

Division of Aquatic and Wildlife Resources

Guam Department of Agriculture



Annual Report Fiscal Year 1997

Guam
Aquatic
and
Wildlife
Resources
Annual
Report
FY'97

ANNUAL REPORT FISCAL YEAR 1997

**GUAM
DIVISION OF AQUATIC & WILDLIFE RESOURCES
Robert D. Anderson, Chief**

**DEPARTMENT OF AGRICULTURE
Michael W. Kuhlmann, Director**

Edited by:

**Gerald W. Davis
Todd J. Pitlik
Gary J. Wiles**

**PERIOD COVERED:
October 1, 1996 to September 30, 1997**

Guam
Aquatic
and
wildlife
resources
Annual
Report
FY '97

Grades May 2000
unacc.

ACKNOWLEDGEMENTS

The Division of Aquatic and Wildlife Resources, Department of Agriculture, wishes to acknowledge the following persons and organizations for their assistance in our work:

Members of the Guam Fishing & Boating Association, the Marianas Fishing Derby Committee and the manager of the Guam Fishermens's Coop for allowing fishery biologists to examine their fish;

Fishermen who have cooperated with fishery data collection;

Individuals who have reported poaching activities and bird sightings;

Hunters who have cooperated with wildlife data collection by filling out and returning hunter questionnaires;

Base Commanders of the U.S. Ordnance Annex (formerly Naval Magazine), Naval Station, Naval Computer and Telecommunications Master Station, and Andersen Air Force Base;

Security Officers and their staffs at the U.S. Ordnance Annex (formerly Naval Magazine), Naval Computer and Telecommunications Master Station, and Andersen Air Force Base;

Staff and management of KGTF Channel 12;

Print and electronic media for coverage of our programs and activities and for their support of conservation education programs;

Personnel of the Naval Oceanographic Command Detachment for providing weather data;

The Marine Lab, University of Guam;

Personnel from the Office of Enforcement, National Marine Fisheries Service, National Oceanic and Atmospheric Administration, U.S. Department of Commerce;

Personnel from the Division of Law Enforcement, U.S. Fish and Wildlife Service, U.S. Department of the Interior.

TABLE OF CONTENTS

FY 1997

		Page
Section 1	Coordination and Administration – Project FW-3C-5 (Federal Aid in Sport Fish and Wildlife Restoration Acts)	
Job C-1-1	Coordination of Guam’s Fish and Wildlife Programs	1
Job C-3-1	Public Information and Education of Guam’s Fish and Wildlife Restoration and Endangered Species Programs	4
Section II	Guam Fisheries Investigations – Project F-1R-5 (Federal Aid in Sport Fish Restoration Act)	
Job F-1-1-1	Offshore Fisheries Survey	7
Job F-1-1-2	Inshore Fisheries Survey	15
	Inshore Aerial Survey (Appendix 1)	28
	Kid’s Fishing Derbies (Appendix 2)	31
Job F-2-1-1	Freshwater Monitoring	35
Job F-3-1	Technical Guidance to Projects Affecting Guam’s Fish Resources	52
Section III	Guam Fisheries Development – Project F-2-D (Federal Aid in Sport Fish Restoration Act)	
Job F-2-D-6	Marine Fish Habitat Improvement and Aggregating Devices	55
Job F-2-D-7	Merizo Pier and Boat Ramp Facility	59
Job F-2-D-9	Development of Inshore Fishing Access Facilities	60
Job F-2-D-10	Restoration of Masso Reservoir	62
Job F-2-D-11	Fabrication and Deployment of Shallow Water Moorings	63
Job F-2-D-12	Maintenance and Redeployment of FADs and SWMs	70
Non-Federally Funded Projects		
	Commercial Fisheries on Guam	75

		Page
Section IV	Guam Wildlife Investigation Project W-1R-5 (Federal Aid in Wildlife Restoration Act)	
Job W 1-1-1	Determination of Current Population Size and Distribution of Guam Deer	77
Job W 1-2-1	Population Size and Distribution of Wild Pigs on Guam	82
Job W 2-1-2	Population Numbers and Distribution of Philippine Turtle Doves	85
Job W 2-2-1	Population Size and Distribution of Black Francolin on Guam	88
Job W 3-1-1	Population Size and Distribution of Wild Asiatic Water Buffalo on Guam	91
Job W 4-1-1	Survey and Inventory of Non-Game Birds	95
Job W 4-1-2	Survey for Mariana Crows and Their Nest Sites	105
Job W 5-1-1	Natural History, Biology, and Habitat Protection for Marianas Fruit Bats	112
Job W 5-1-4	Roost Site Characteristics of Marianas Fruit Bats	118
Job W 6-1	Technical Guidance to Projects Affecting Guam's Wildlife Resources	119
Section V	Guam Endangered Species Investigation Project E-1-12 (Section 6 – Endangered Species Act of 1973)	
Job 4-1	Captive Breeding of Endangered Native Birds	124
Job 4-2	Development of an Experimental Population of Guam Rails in the Commonwealth of the Northern Mariana Islands	128
Job 4-3	Development and Testing of Control Methods for Enhancing Reproduction Affected Endangered Native Forest Birds and Fruit Bats	135

JOB PROGRESS REPORT COORDINATION PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: FW-3C-5
SUB-PROJECT NO.: C-1
JOB NO.: 1

JOB TITLE: Coordination of Guam's Fish and Wildlife Programs (1630, 2630)

PERIOD COVERED: October 1, 1996 to September 30, 1997

OBJECTIVES

To plan, coordinate, supervise, and administer all fish and wildlife restoration and endangered species programs.

PROCEDURES

1. Supervise the planning and documentation of the Fish and Wildlife programs.
2. Administer all fiscal and budgetary matters and coordinate with the Central Accounting and Budget Office.
3. Administer all personnel matters including recruitment of off-island staff.
4. Represent the Division and Department of Agriculture in all matters pertaining to Fish and Wildlife Resources.

RESULTS

The Division experienced several staff changes during the year and has experienced significant success in recruiting new staff. All reported actions occurred between October 1, 1996 and September 30, 1997. There were 24 personnel actions involving hiring (13), transfer in (1), transfer out (2), promotion (2), and resignation (2) during FY97. There were also two employees that worked for the Division through a Public Health apprentice program. All total there were 14 new employees hired while 6 left. This filled the majority of the pending position vacancies and should allow considerable program progress. The position changes within the respective section are as follows.:

Administration: Arlene Tedtaotao the Secretary Typist I resigned in June. Lillian Rebanio was hired as a Secretary Typist I in September.

Wildlife: The following personnel were hired in the Wildlife section: Dana Lujan Wildlife Game Biologist II in February, Susanne Medina as an Aviculturist (Wildlife Biologist II) in July, Mark Richman as an Endangered Species Biologist II in August, Allan Searle as a Wildlife Herpetologist (Biologist II) in September, and Alicia Demaracut as a Wildlife Biologist I in April. The following were hired as Wildlife Biological Aides: Gilbert Acosta and Michelle Pleskonko in April, Raymond Wolford in May, and Jeffery Quitugua and Romano Santos in August, Lamont Henderson was promoted to Wildlife Biologist I in August, Dante Buensuces was transferred to a Wildlife Biological Aide in March from the Fadian "Guam Aquaculture Training and Development Center", Benedict

Reyes transferred to Guam Department of Customs and Quarantine in April, Sean Slappy resigned in September, Jesse Taijeron and August Charfauros were employed as temporary workers under the Guam Public Health apprentice program whose contracts lapsed in June and September respectively and Franklin Cruz transferred to Public Works in May.

Fisheries: The following were hired as Fisheries Biologist I's: Veronica Cummings in April, and Jay Gutierrez in August. Georgette Concepcion resigned in July.

Technical Assistance: Marvin Aguilar transferred to Guam Mass Transit in September.

Law Enforcement: Officer Ed Nieves transferred to Superior Court in June.

Division staff spent the first quarter preparing the annual Job Progress Reports on the research and other activities conducted during FY96 under its various federal programs and submitted them to the US Fish and Wildlife Service Regional Office.

Staff also devoted considerable effort to preparing the Federal Aid project documentation necessary to obligate funds for the Division's various programs during FY98. This documentation included annual Grant Agreements for 1) Project FW-3C, Guam Fish and Wildlife Coordination, which covers the administration and coordination of the Division's Federal Aid programs and which is jointly funded by wildlife (PR) and sport fisheries (DJ) funds; 2) Project F-1R, Guam Sport Fish Investigations, which covers sport fish research and survey activity and which is funded with sport fisheries (DJ) funding; and 3) Project W-1R, Guam Wildlife Investigations, which covers wildlife research and survey activity and which is funded with wildlife (PR) funds. In addition, annual Grant Agreements and Amendments were prepared for the Division's various Fisheries Development and Endangered Species Investigations (Section 6) projects.

In the summer of 1997 a request to amend the Endangered Species translocation subpermit for the Marianas Crow to bring adults, chicks and eggs to Guam to stimulate reproduction was resubmitted. The status of the request is pending determination by the Endangered Species Recovery Team.

The Division Chief and his staff represented the Division and the Department of Agriculture in all matters relating to fish and wildlife resources. This frequently entailed meetings with other agencies of the Government of Guam, various Federal agencies, and the military.

The Division's administration and coordination responsibilities are 50% funded by local funds.

The Chief served on the Area Committee for Oil Spill Response and he is a member of the Criminal Justice Advisory Committee at Guam Community College. Additionally, he continued to serve as a member of the Technical Advisory Committee for the I Tano'ta land use plan being developed by the Territorial Planning Council and served as a member of the Technical Review Committee (now Rehabilitation Advisory Board [RAB]) for the Andersen Air Force Base Institution Restoration Program (IRP) as well as for Naval installations other than Naval Air Station. The Chief supervised the locally-funded Technical Assistance Program, staffed by Biologist II Marvin Aguilar until his resignation.

Division participated in a series of meetings with the Department of Parks and Recreation, the Chamorro Land Trust Board, and the Bureau of Planning to review the inventory of Government of Guam lands to determine which have the best potential for incorporation into the Territorial Park System as Conservation Areas in accordance with the mandate of

PL 22-18, which requires that the two Departments (Agriculture and Parks) develop a comprehensive master plan before any additional lands are so designated. A draft plan was completed and being reviewed at the end of the report period.

The Chief, Fisheries Supervisor, and Wildlife Supervisor serve as members of the Area Committee's Oiled Wildlife Cleanup Subcommittee, which was established to review current cleanup techniques for inclusion in the Area Plan.

Because the Occupational Safety and Health Administration requires a certain level of hazardous materials training for all persons involved in an oil spill response, the Coast Guard provided an 8-hour HAZMAT recertification training to a number of Division staff who completed a 40-hour Hazardous Waste Operations (HAZWOPER) course the previous year.

Division staff made a number of off-island trips related to Federal Aid and other programs:

The Division Chief represented the Division at the initial meeting of the National Research Council's Committee on the Scientific bases for Preservation of the Mariana Crow in Honolulu in April.

Fisheries Supervisor, Gerry Davis attended the Federal Data Coordinating Committee meetings in November of 1996 and again in April of 1997, both funded by WPacFIN grant money.

Biologist III Andrew Torres attended the Bottomfish Plan Monitoring Team meeting in Honolulu, Hawaii in March funded by the Western Pacific Regional Fisheries Management Council.

Fisheries Biologist III Tom Flores attended the Pelagic Plan Monitoring Team meetings in Honolulu in October of 1996, May, July and September of 1997, funded by the Western Pacific Regional Fisheries Management Council. He also attended a workshop on pumpout facilities hosted by the US Fish and Wildlife Service in Portland in September of 1997.

Biologist III Kelly Brock and Wildlife Biologist II Grant Beauprez made numerous trips to Rota in support of the Rota Rail Introduction Project. In addition to radio telemetry monitoring of released rails, they conducted rodent and predator trapping. Dante Buensuces also traveled to Rota as part of the rail introduction project in August. Mr. Beauprez also presented a paper at the Cooper's Ornithological Society in May in Kona Hawaii. Ms. Brock also attended the World Association of Zoo Animals conference in April in Phoenix Arizona. She went on to the Philadelphia Zoo after the conference to work on the Marianas Kingfisher captive breeding program.

The Division hosted a number of off-island visitors during the year.

PROGRAM COST

The estimated cost of the Coordination/Administration project was \$65,000.

This report was prepared by: Gerry Davis

JOB PROGRESS REPORT INFORMATION/EDUCATION PROGRAM

STATE: Territory of Guam

PROJECT NO.: FW-3C-5
SUB-PROJECT NO.: C-3
JOB NO.: 1

JOB TITLE: Public Information and Education on Guam's Fish and Wildlife Restoration and Endangered Species Programs (2520, 2530, 1630)

PERIOD COVERED: October 1, 1996 to September 30, 1997

SUMMARY

The Public Information Officer Position remained unfilled while efforts are underway to create an Education Specialist Position. The position description was approved by the Governor and is pending review by the Civil Service Commission.

The Division conducted a two-day Marine Fishing Derby for Kids Only at Andersen Air Force Base's Serena Beach in June. A fishing clinic open to the public was also conducted on the Saturday prior to this event.

The Division continues to distribute posters, flyers, pamphlets, coloring books and videos to the public and schools

The Division continued to issue press releases on its projects and activities, set up static public displays, conduct press conferences, submit feature articles to the print media, make radio and television appearances, and respond to requests for information from students and members of the general public.

BACKGROUND

The Public Awareness and Conservation Education Program (PACE) was established in support of the Division's mission to protect, preserve, develop and enhance Guam's aquatic and wildlife resources. The program consists of school presentations dealing with aquatic and wildlife conservation, kids' fishing derbies, the production of resource materials for classroom use including coloring books, activity guides, posters and informational flyers, news releases, static public displays, public service announcements, press conferences and feature articles.

Up until FY90, the program was facilitated primarily by a Public Information Officer, and periodically by staff biologists. Since FY90, Conservation Officers have also provided direct support to the PACE effort by conducting classroom visits to address the enforcement aspects of conservation.

The effectiveness of the PACE programs and activities can best be measured by the community's continuing response in reporting suspected poachers and poaching activities to conservation officers and police, the growing interest and demand for resource conservation materials, and the increase in teacher and student requests for fish and wildlife presentations. As in the past, residents continue to report bird sightings, bring in injured birds or birds presumed to be

endangered species, and generally to encourage the institution of more intensive management programs for Guam's fish and wildlife resources.

PROCEDURES AND RESULTS

Activities and efforts during FY97 included the following:

1. Class presentations on endangered species, coral reef ecology and fish and wildlife conservation in general, were delivered public and private elementary schools, middle schools, and high schools, university classes, and groups such as the 4-H Club, Cub Scouts, and Department of Parks and Recreation Summer Camp. Division staff biologists and conservation officers also provided support to the University of Guam's fisheries training program.
2. The Division distributed color posters on the to every school and library on the reef and pelagic fishes of Guam. Copies of the poster are available to the public upon request at the Division office. The development and production of the posters were funded by the Sport Fish Restoration Program.
3. The Division distributed color posters on the Dangerous and Poisonous Sea Creatures to the public. Poster production was funded by the Guam Coastal Zone Management Program while DAWR provided some of the photographs and technical support.
4. The Division distributed color flyers of Guam's animal, plant and marine life to the schools and public. The PACE program funded the development and production of the flyers, while the Coastal Zone Management Program funded the printing.
5. The Division distributed color posters on the Mariana fruit bat (*Pteropus mariannus*) to every school and library on Guam. Copies of the poster are available to the public upon request at the Division office. The development and production of the posters were funded by the Wildlife Restoration Program; printing funds came from the Bureau of Planning's Coastal Management Program through a grant from the National Oceanic and Atmospheric Administration.
6. The Division continues to issue copies of a 30-minute video on coral reef ecology intended for use in public fisheries presentations and for distribution to school and public libraries, museums, and other educational institutions.
7. Displays on the brown tree snake and various fish and wildlife conservation programs were set up during Earth Week and other similar events.
8. Division programs and activities continue to gain extensive media coverage. Newspaper and television feature articles on Guam rail, Micronesian kingfisher and Mariana crow recovery efforts are periodically done, as are hunting and fishing activities and enforcement. In addition, a number of off-island media visited Guam during the year to film and document brown tree snake impact on Guam's natural resources and efforts to control its spread to other islands.
9. The Division participated in Youth Leadership Day activities.
10. Division staff developed press releases and feature articles and participated in media conferences on various conservation topics.

RECOMMENDATIONS

1. Hire an Education Specialist as soon as Civil Service approved the position.
2. Develop and implement a Hunter Education program to compliment the existing PACE program utilizing Division biologists, conservation officers, and community volunteers as instructors.
3. Develop and implement specific public education programs on the brown tree snake and the recovery programs for the Mariana crow, the Micronesian kingfisher, the Guam rail, and other endangered indigenous species. Attempt to develop feelings of cultural pride and concern for the recovery of indigenous wildlife.
4. Develop a teacher-training program for aquatic education.
5. Continue to hold freshwater and marine fishing derbies and clinics for children. In addition, develop a new series of freshwater and marine fishing derbies, clinics, and other events for older youths, ages 13 through 17, and for adults.
6. Explore the possibilities of corporate sponsorship for specific endangered species recovery, conservation, and public awareness programs.
7. Continue aquatic and wildlife presentations at public and private schools, libraries, summer camps, after-school programs, and civic organizations.
8. Develop and implement workshops on various natural resource conservation topics for public and private school teachers.
9. Continue public awareness program through press releases, news articles, press conferences and other media to keep the public informed of the progress and accomplishments of the Division's fish, wildlife and endangered species programs.
10. Update existing and develop new public service announcements for television and radio.
11. Coordinate the Division's participation in mutual programs and projects with Guam's Department of Education, Guam Coastal Management Program, Sea Grant, the University of Guam Extension Service, Department of Parks and Recreation, the Guam Environmental Protection Agency, the U. S. Fish and Wildlife Service, the U. S. National Park Service, and the Guam National Wildlife Refuge.
12. Develop a traveling exhibit program to present information on the Division's fish and wildlife conservation and management programs and natural resource conservation educational materials in village community centers.

PROGRAM COST

The estimated cost of the Division's PACE Program was \$20,000.

This report was prepared by: Gerry Davis

JOB PROJECT REPORT **RESEARCH PROJECT SEGMENT**

STATE: Territory of Guam

PROJECT NO: F-1R-5
SUB-PROJECT NO.: F-1
STUDY NO.: 1
JOB NO.: 1

STUDY 1: Fisheries Participation, Effort, and Harvest Surveys (2430)

JOB 1: Offshore Fisheries Survey

PERIOD COVERED: October 1, 1996 to September 30, 1997

SUMMARY

Monthly offshore fisheries surveys were conducted at the Agana Boat Basin, Agat Marina, and the Merizo Pier from October 1996 through September 1997. The FY97 island-wide offshore catch, from primarily small recreational-type vessels, is estimated to be 492.2 metric tons (Table 1). The bulk of the catch, 357.0 m.t., was landed by the trolling method, which consisted primarily of five pelagic species. Bottomfishing produced an estimated 48.1 m.t., primarily snappers, emperors, and groupers, while night-light jigging produced an estimated 6.0 m.t. Spearfishing, both SCUBA spear and snorkel spear, produced 49.5 m.t. of finfish and invertebrates. An additional 31.2 m.t. of finfish were landed by other methods such as gillnet, castnet, jigging, and spincasting.

TABLE 1: Composition of the Guam Offshore catch during FY97. Weights are in metric tons (m.t.).

Offshore Fishing Method	FY97 Catch
Trolling	357.4
Bottomfishing	52.1
Spearfishing	44.2
Atulai night-light jigging	5.4
Other Methods	31.2
TOTAL FY97 OFFSHORE CATCH	490.3

BACKGROUND

Effective management of the island's offshore fishery resources requires the collection and analysis of data on fishing effort, methods, and harvest. In order to identify trends in fishing participation, effort, and catch, the Department of Agriculture's Division of Aquatic and Wildlife Resources (DAWR) has been monitoring offshore fishing activities for the past 20 years. Over this period of time, survey and analysis methodologies have changed in response to fluctuations in budget and staff, as well as changes in the fishery. During FY97, the National Marine Fisheries Service (NMFS) and DAWR have been developing a computerized database program to collect and analyze the offshore fisheries data. The data in the FY97 report should be considered as preliminary data, as the new expansion process used to obtain the FY97 data is in the early phase of being verified. The statistical basis for the expansion can be found in NOAA SWFC Admin. Reports H-83-21C and H-92-08.

OBJECTIVES

1. To quantify fishing participation, effort, and catch which occurs outside the reef margin in boats.
2. To collect biological data from the specimens examined during interviews.

PROCEDURES

During FY97, interviews of returning offshore fishing parties were conducted on four days each month at the Agana Boat Basin (two weekends and two weekdays), two days each month at the Agat Marina (one weekend and one weekday), and two days each month at the Merizo Pier (one weekend and one weekday). Each of these days were randomly selected weekdays (WD) and weekend days (WE/H). Agana Boat Basin surveys consist of two periods, one from 0500 to 1200 hours and from 1600 to 2400. Agat Marina and Merizo Pier survey times differed slightly in the morning survey hours, 0530 to 1200 and 0600 to 1100 hours respectively. Island-wide participation was determined by means of a morning and evening survey, one weekday and one weekend a month, of all public boat launching areas in which all trailers attached to vehicles were counted, but no interviews were taken. This assumes that the percentage of boats operating out of the Agana Boat Basin, Agat Marina, and the Merizo Pier combined engaging in fishing, and the proportion of those fishing boats engaging in each offshore method is representative of the island as a whole.

Several major changes were made in the data expansion process during FY97. These changes include using quarterly rather than monthly expansions, using boat log data to calculate participation in the expansion process, expanding data from three ports rather just the Agana Boat Basin, and separating charter and non-charter fishing activity. Documentation of the entire process will be available in FY98 report.

RESULTS

Trolling

Five major pelagic species account for 95.6% of the total troll catch by weight (Table 2). Mahimahi (*Coryphaena hippurus*) made up 31.4% of the troll catch, followed by bonita (*Katsuwonus pelamis*; 28.9%), wahoo (*Acanthocybium solandri*; 13.0 %), Pacific blue marlin (*Makaira mazara*; 11.7%), and yellowfin tuna (*Thunnus albacares*; 10.6%). Approximately 2% of the troll catch consists of requiem sharks (*Carcharhinidae*), rainbow runner (*Elagatis bipinnulatus*), barracuda (*Sphyraena barracuda*), kawa kawa (*Euthynnus affinis*), dogtooth tuna (*Gymnosarda unicolor*), species of *Lutjanidae* and *Lethrinidae*, and other incidental troll catch species. For approximately 2.1% of the troll catch, an estimated catch, rather than a species break down, was obtained due to time constraints imposed by the fishermen. For these interviews, effort and participation data was collected.

Overall troll catch decreased slightly, approximately 2%, compared with FY96, 357.4 m.t. down from 363.6 m.t. Landings decreased 11% for mahimahi (112.2 m.t. from 125.9 m.t.), decreased 10% for yellowfin tuna (37.8 m.t. from 42.1 m.t.), and decreased 2% for Pacific blue marlin (41.8 m.t. from 42.7 m.t.). Landings for bonita increased 6% (103.1 m.t. from 97 m.t.), increased 5% for wahoo (46.6 m.t. from 44.4 m.t.), and increased 39% for other troll species. Total kilograms of troll fish per boat trip increased 8%, 23.9 kg/boat trip compared with 22.2 kg/boat trip in FY96. Comparing troll participation with FY96, the number of trolling boat trips decreased 10%, 14,947 boat trips from 16,786 boat trips, and the number of people participating decreased 23%, 55,810 down from 72,425.

With effort, the number of boat hours decreased 6%, 62,738 hours down from 66,638 boat hours.

TABLE 2: Composition of the Guam troll catch during FY97 by most common species. Weights are in kilograms (kg).

Troll Species	Total Catch (kg)	% Total Catch
<i>Coryphaena hippurus</i>	112,202	31.4
<i>Katsuwonus pelamis</i>	103,148	28.9
<i>Acanthocybium solandri</i>	46,570	13.0
<i>Makaira mazara</i>	41,761	11.7
<i>Thunnus albacares</i>	37,784	10.6
"assorted trolling"	7,460	2.1
<i>Carcharhinidae</i>	2,376	>1
<i>Elagatis bipinnulatus</i>	2,067	>1
<i>Sphyrna barracuda</i>	1,460	>1
<i>Euthynnus affinis</i>	1,250	>1
<i>Gymnosarda unicolor</i>	544	>1
<i>Aprion virescens</i>	408	>1
<i>Tetrapterus angustirostris</i>	155	>1
<i>Carangidae</i>	162	>1
other <i>Lutjanidae</i>	37	>1
Other	38	>1
TOTAL	357,423	

Charter trolling remains a significant portion of the trolling activity. Charter activity accounted for 24% of the troll catch (86.7 m.t.), 25% of boating hours, 15,784 hours, and 36% of all trolling trips, 5,305 trips. The number of people participating in charter troll trips was 39,972, or 56% of all people participating in charter trolling trips.

Bottomfishing

An estimated 52.1 m.t. of bottomfish was landed during FY97, a decrease of 22% from FY96. The bottomfish catch (Table 3) was dominated by three major families: *Lethrinidae* or emperors (28.9%), *Lutjanidae* or snappers (14.7%), and *Serranidae* or groupers (11.8%). The dominant bottomfish species were the yellowstripe emperor (*Lethrinus obsoletus*, 4.1 m.t.), the redgilled emperor (*L. rubrioperculatus*, 2.9 m.t.), the blackspot emperor (*L. harak*, 2.6 m.t.), the yellowlip emperor (*L. xanthochilus*, 2.2 m.t.), the black-tipped grouper (*Epinephelus fasciatus*, 1.8 m.t.), the yellowtail kalikali (*Pristipomoides auricilla*, 1.6 m.t.), the honeycomb grouper (*E. merra*, 1.5 m.t.), the jobfish or uku (*Aprion virescens*, 1.3 m.t.), and the lyretail grouper (*Variola louti*, 1.0). Other important families include trevallies (*Carangidae*, 2.7 m.t.), triggerfish (*Balistidae*, 2.1 m.t.), sharks (*Carcharhinidae*, 1.4 m.t.), and mullets (*Mullidae*, 1.1 m.t.). For approximately 25% of the bottomfish catch, an estimated bottomfish catch, rather than a species break down, was obtained due to time constraints imposed by the fishermen. For these interviews, effort and participation data was collected.

Comparing bottomfish participation with FY97, the number of boat trips bottomfishing did not change significantly, 7,139 in FY97 compared with 7,126 in FY96. However, the number of persons participating increased 108%, 39,660 compared with 19,108 in FY96. A significant number of these people, approximately 74% of these people, participated in charter bottomfish trips but may not have actually fished. Comparing bottomfish effort, the

number of boat hours decreased 13%, 28,469 hours down from 32,844 hours in FY96. Comparing overall catch rate (kg/boat trip), overall catch rate decreased 24%, 7.31 kg/boat trip compared with 9.6 kg/boat trip in FY96. The catch rate for non-charter bottomfish trips, 8.7 kg/boat trip, was significantly higher than for bottomfish charter boats, 3.23 kg/boat trip.

TABLE 3: Composition of the Guam bottomfish catch during FY97 by Family* and most common species. Estimated weights are in kilograms (kg).

FAMILY	Total Catch (kg)	% Total Catch
<i>Lethrinidae</i> *	13,925	28.9
<i>L. obsoletus</i>	4,080	29.3+
<i>L. rubrioperculatus</i>	2,943	21.1+
<i>L. harak</i>	2,651	19.0+
<i>L. xanthochilus</i>	2,160	15.5+
<i>L. olivaceous</i>	828	5.9+
<i>Lethrinidae sp.</i>	409	2.9+
<i>Gnathodentex aurolineatus</i>	378	2.7+
<i>Lutjanidae</i> *	7,062	14.7
<i>Pristipomoides auricilla</i>	1,588	22.5+
<i>Aprion virescens</i>	1,252	17.7+
<i>Etelis carbunculus</i>	699	9.9+
<i>P. zonatus</i>	679	9.6+
<i>L. monostigmus</i>	670	9.5+
<i>L. kasmira</i>	594	8.4+
<i>Serranidae</i> *	5,682	11.8
<i>Epinephelus fasciatus</i>	1,829	32.2+
<i>E. merra</i>	1,501	26.4+
<i>Variola louti</i>	1,043	18.4+
<i>E. hexagonatus</i>	328	5.8+
<i>Carangidae</i> *	2,720	5.7
<i>Balistidae</i> *	2,147	4.5

*over 1000 kg.. +% in respective Family.

Deepwater species comprised only 9% of the total bottomfish catch. A significant drop in total deepwater bottomfish catch was observed 4.0 m.t. compared with 16 m.t. in FY96. Deepwater species encountered during FY97 consists of *Etelis*, *Pristipomoides*, and *Epinephelinae* species (Table 4). Dominant deepwater bottomfish were the yellowtail kalikali (*P. auricilla*, 1.6 m.t.), ehu (*E. carbunculus*, 699 kg), gindai (*P. zonatus*, 679 kg), and opakapaka (*P. flavipinnis*, 308 kg).

Atulai Night-Light Jigging

Atulai night-light fishing was encountered year round during FY97. An estimated 5.4 m.t. of fish were landed, 45% less than the 9.9 m.t. harvested in FY96 (Table 5). A 45% decrease in the number of atulai night jigging trips was observed 401 trips down from 732 trips in FY96. There was no significant change in catch per boat trip, with 13.5 kg/boat trip observed in FY96 and 13.6 kg/boat trip observed in FY97. Approximately 95% of the catch consisted of atulai (*Selar crumenophthalmus*, 5.1 m.t.). The remaining 5% were incidental catches of trevallys (*Carangidae*, 109 kg.), snappers (*Lutjanidae*, 86 kg.), soldier

fishes and squirrelfishes (*Holocentridae*, 79 kg.), and emperors (*Lethrinidae*, less than 50 kg.).

TABLE 4: Composition of the Guam deep bottomfish catch during FY97. Estimated weights are in kilograms (kg).

FAMILY	Total Catch (kg)	% Total Deep Bottomfish Catch
<i>Pristipomoides auricilla</i>	1,588	39.4
<i>Etelis carbunculus</i>	699	17.3
<i>P. zonatus</i>	679	16.8
<i>P. flavipinnis</i>	308	7.6
<i>Aphareus rutilans</i>	196	4.9
<i>P. filamentosus</i>	111	2.7
<i>Saloptia powelli</i>	51	1.3
<i>E. coruscans</i>	39	0.9
<i>P. argyrogrammicus</i>	11	0.3
Misc. deep bottomfish	350	8.7
Total deep Bottomfish	4,029	

TABLE 5: Composition of the Guam atulai (*Selar crumenophthalmus*) night jigging catch during FY 97. Estimated weights are in metric tons (m.t.).

SPECIES	Total Catch (m.t.)
<i>Selar crumenophthalmus</i>	5.6
<i>Carangidae</i>	0.1
<i>Lutjanidae</i>	>0.1
<i>Holocentridae</i>	>0.1
<i>Lethrinidae</i>	>0.1
Total Catch (m.t.)	6.0

Spearfishing

An estimated 44.2 m.t. of speared fish, crustaceans, and mollusks were landed during FY97 (Table 6). The spearfish finfish catch (Table 7) was dominated by surgeonfishes (*Acanthuridae*, 19.8 m.t.) and parrotfishes (*Scaridae*, 6.7 m.t.), *Naso unicornis* was the most important spearfish specie taken, comprising 80% of the *Acanthuridae* catch and 33% of the total spearfish catch. *Trochus niloticus* ranked third in overall catch by weight, with 3.8 m.t. taken, 8% of the total spearfishing catch. Next in importance were the rudderfishes (*Kyphosidae*; 1.9 m.t.), emperors (*Lethrinidae*, 1.6 m.t.), groupers (*Serranidae*, 1.5 m.t.), goatfishes (*Mullidae*, 1.5 m.t.), rabbitfish (*Siganidae*, 1.3 m.t.), and snappers (*Lutjanidae*, 1.2 m.t.). With the spearfish invertebrate catch, 1.8 m.t. of octopus were taken, second to *Trochus niloticus*.

Spearfishing participation, effort, and catch decreased in FY97 compared with FY96. The number of spearfishing trips decreased 22%, 2,091 from 2,691 trips, the number of persons spearfishing decreased 7%, 8,216 persons from 8,800 persons in FY96, boat hours decreased 25%, 5,399 boat hours down from 7,221 boat hours, and spearfish catch decreased 26%, 44.2 m.t. compared with 59.3 m.t.

TABLE 6: Composition of the Guam spearfish catch during FY96 by Family* and most common species. Estimated weights are in kilograms (kg).

FAMILY	Total Catch (kg)	% Total Catch**
<i>Acanthuridae</i>	19,841	40.1
<i>Naso unicornis</i>	16,498	33.3
<i>N. lituratus</i>	2,075	4.2
<i>N. caesius</i>	315	+
<i>Scaridae</i>	6,705	13.6
<i>Hipposcarus longiceps</i>	2010	4.1
<i>S. sordidus</i>	1190	2.4
<i>S. schlegeli</i>	957	1.9
<i>S. altipinnis</i>	788	1.6
<i>Scarus sp.</i>	350	+
<i>S. microrhinos</i>	346	+
<i>Trochus niloticus</i>	3,779	7.6
<i>Kyphosidae</i>	940	1.9
<i>K. cinerascens</i>	808	1.6
<i>K. vaigiensis</i>	132	+
<i>Octopus sp.</i>	872	1.8
<i>Lethrinidae</i>	812	1.6
<i>L. xanthochilus</i>	308	+
<i>L. harak</i>	145	+
<i>Serranidae</i>	736	1.5
<i>Plectropomus laevis</i>	173	+
<i>Variola louti</i>	132	+
<i>Epinephelus polyphekadion</i>	107	+
<i>Mullidae</i>	725	1.5
<i>Parupeneus bifasciatus</i>	148	+
<i>Siganidae</i>	658	1.3
<i>S. punctatus</i>	392	+
<i>S. argenteus</i>	215	+
<i>Lutjanidae</i>	592	1.2
<i>Macolor niger</i>	159	+
<i>L. gibbus</i>	146	+
<i>L. bohar</i>	108	+
<i>Labridae</i>	472	+
<i>Cheilinus undulatus</i>	312	+
<i>Carangidae</i>	384	+
<i>C. melampygus</i>	273	+
<i>Holocentridae</i>	259	+
<i>Panilurus penicillatus</i>	243	+
<i>Muraenidae</i>	241	+
<i>Gymnothorax javanicus</i>	241	+
<i>Orectolobidae</i>	230	+
<i>Nebrius concolor</i>	230	+
<i>Balistidae</i>	122	+
<i>Carpilius maculatus</i>	74	+
<i>Haemulinae</i>	63	+
<i>Ephippidae</i>	52	+

*Families with estimated catches greater than 50 kg. ***% greater than 1%.

+less than 1% of total spearfish catch.

TABLE 7: Comparison of Participation and Catch (m.t.) between Snorkel spearfishing, scuba spearfishing, and mixed spearfishing.

Spear Method	Number of Trips	Catch (m.t.)	Catch per Trip (kg/boat trip)
Snorkel spear	1,437	21.2	14.8
Scuba spear	603	21.9	36.2
Mixed spear	51	1.1	22.0
TOTAL	2,091	44.2	

Snorkel spearfishing, SCUBA spearfishing, and mixed spearfishing, had significantly different participation and catch rates (Table 7). Comparing participation, snorkel spearfishing comprised 70% of both spearfishing trips and persons participating in spearfishing. Comparing effort, snorkel spearfishing accounted for 78% of total spearfishing hours. Comparing overall catch, snorkel spearfishing accounted for 49% of the total spearfishing catch, while SCUBA spear was slightly less at 48%. SCUBA spearfishing had a significantly higher catch rate compared with snorkel spearfishing, 36.2 kg/boat trip compared with 14.8 kg/boat trip for snorkel spearfishing. Mixed spearfishing activity accounted for less than 5% of spearfishing trips, overall spearfish catch, persons participating, and hours spent spearfishing.

Other Methods

Other less common fishing methods encountered during the offshore surveys accounted for 31.2 m.t. of finfish, 6% of the total offshore catch. This category experienced a thirteen-fold increase in finfish catch compared with FY96. This category was dominated by gillnetting, with castnetting, spincasting, and jigging.

Approximately 94% of the catch by these less encountered methods, 29.4 m.t., were taken by gillnetting. *Carangidae* accounted for 19.2 m.t., or 65% of the gillnet catch, followed by *Lethrinidae* (2.1 m.t.), *Scaridae* (1.1 m.t.), *Acanthuridae* (0.9 m.t.), and *Siganidae* (0.6 m.t.). Castnetting accounted for 3.4 m.t. of finfish, dominated by rudderfish (*Kyphosidae*, 1.4 m.t., 41% of the castnet catch), goatfish (*Mullidae*, 0.4 m.t.), and surgeonfishes (*Acanthuridae*, 0.3 m.t.). An additional 1.2 m.t. of finfish were taken by spincasting, with mahimahi (78%) dominating this category. The use of spincasting gear during trolling trips during mahimahi season has increased in popularity, especially with charter boats.

DISCUSSION

The total offshore catch for FY97 was slightly less compared with FY96, less than 3%. All major offshore methods, trolling, bottomfishing, spearfishing, and atulai night light jigging, had decreases in total catch compared with FY96. Comparing catch rates (kilograms of fish caught per boat trip), a significant decrease, 24%, was observed only with bottomfishing, with no significant difference observed with trolling and atulai night light jigging. A decrease in the total catch for trolling, bottomfishing, spearfishing, and atulai night light jigging could be attributed, in part, to an increase in the number of bad weather days due to storms in FY97. The decrease in bottomfish catch rate could be reflective of an over-utilized resource, a trend observed in the last few years with bottomfishing.

Charter boat activity comprises a significant portion of the trolling activity. However, during the end of FY97, a significant decrease in the number of charter trolling trips a day

was observed. This was due primarily to a slump in tourism. This trend will be observed closely during FY98, and its impact on trolling monitored.

A major deficiency with using this preliminary data for the FY97 offshore report was the lack of an consistent adequate measure of CPUE to compare catch rates between FY96 and FY97. The only CPUE value available for comparison was kilograms of fish caught per boat trip. This measure of CPUE is not useful since the length of a fishing trip varies significantly within a method, even more so between charter and non-charter fishing activities. Although this measure of CPUE was reported in FY96, charter and non-charter activity were not separated out during FY96 making any comparison with FY97 impossible. Other measures of CPUE that were reported in FY96 such as "kg of catch per gear-hour" or "kg of catch per person-hour" were not available at the time this report was written.

RECOMMENDATIONS

It is recommended that the new survey design and new computerized database being developed with the assistance of NMFS be completed and implemented during FY98. Data from FY92 to the FY97 should be inputted during FY98 into the new data model, and an expansion run on this time series. This should standardize as much as possible, the offshore data reporting to obtain a clearer and more accurate picture of the evolution of the offshore fisheries on Guam.

PROGRAM COSTS

The estimated cost of the Offshore Fisheries Survey Project was \$159,000.

Report prepared by Thomas Flores, Jr.

JOB PROGRESS REPORT RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: F-1R-5
SUB-PROJECT NO.: F-1
STUDY NO.: 1
JOB NO.: 2

STUDY 1: Fisheries Participation, Effort, and Harvest Surveys (2430)

JOB TITLE: Inshore Fisheries Survey

PERIOD COVERED: October 1, 1996 to September 30, 1997

SUMMARY

Monthly inshore fisheries surveys were conducted along Guam's shoreline from October, 1996 to September, 1997. The total estimated inshore fisheries catch for this time period was 45.6 mt (metric tonnes), 69% of which were finfish (excluding the juvenile rabbitfish or mañahak and juvenile fusilier or achemsom). Hook and line was the most practiced method accounting for 66% of the total participation (excluding seasonal fisheries data) or 44,774 participants. In terms of catch rate, other methods were the most successful of all the daytime methods, yielding approximately 2.12 kg/gear-hour (gh) with a daytime harvest of 4.6 mt, and drag net was the most successful nighttime fishing method, yielding approximately 1.67 kg/gh with a nighttime harvest of 0.10 mt. Hook and line was the most successful method in terms of the overall harvest, yielding approximately 0.15 kg/gh with a total harvest of 15.0 mt. The seasonal mañahak and achemsom catch was estimated at 7.1 mt in FY97.

Aerial Survey

The aerial survey report is included in Appendix 1.

Kid's Fishing Derbies

The kid's fishing derby report is included in Appendix 2.

BACKGROUND

Effective management of Guam's inshore fishery resources requires accumulating data on the types of fishing methods used, fishing pressure, and annual catch. In order to identify trends in fishing participation, effort, and catch, the Division of Aquatics and Wildlife Resources (DAWR) has been monitoring marine fishing activities since the early 1960's. Over this period of time, survey and analysis methodologies have changed in response to fluctuations in budget and staff. In the last several years, however, field survey techniques have been expanded and refined, while estimates of Guam's recreational / subsistence fishing activities have come to be based on more reliable data analysis techniques.

Data Analysis

The establishment of the Fourth Dimension program (4D) has greatly reduced the time needed to compile and analyze Guam's inshore survey data. This has allowed more time to upgrade data collection procedures and to ensure statistical reliability.

OBJECTIVES

1. To establish baseline catch and effort data for reef fish species necessary to develop a fisheries management plan for Guam.
2. To gather limited biological data on Guam's fisheries for management purposes.

PROCEDURES

During FY97, four "inshore-catch" survey days were selected per month. Fishermen-intercept interviews were conducted to determine amount of effort, fishing method, location, reef zone, species composition, and amount caught for both day and night fishing. The day survey covered a six-hour interval (beginning at 0630h) and the night survey covered a five-hour interval (beginning at dusk or 1900h). On any given survey day, one survey area (Figure 1), is randomly selected from either Gun Beach to Adelupe (region I: locations 1-11), Adelupe to Agat (region II: locations 12-34), or Pago to Merizo (region III: locations 71-41) and inshore data collection is restricted within the selected region. However, because of infrequently interviewed methods, e.g., drag netting, and low participation, representative samples can be difficult to obtain. Therefore, if this situation occurred, one or both of the other two adjacent areas could be surveyed.

During FY97, day and night "inshore-participation" surveys were conducted on four randomly selected days per month, which did not occur on the same days as the "inshore-catch" surveys. These surveys entailed making visual observations of fishing participation within readily accessible portions of Guam's coastline (Fig. 1, locations: 1-17, 19-21, 23-26, 29-34, 40-43, 51-53, 56, 57, 60-69, 71, 72). Fishing effort data is collected by instantaneous counts (while driving in a continuous route) around the island. The route is alternated each survey between "clockwise" and "counterclockwise" and the starting locations are randomly selected (Fig. 1). Since the participation survey includes both day and night fishing, start times begin at 0630h and 1900h and end once the entire island circuit has been completed.

Seasonal data on the scad mackerel (atulai), goatfish (ti'ao), jacks (i'e'), and juvenile rabbitfish (mañāhak) were acquired through actual participation and catch surveys. Species of fish that seasonally recruit *en masse* on Guam's reefs, i.e., juveniles of rabbitfish (mañāhak), and fusiliers (achemsom) were not entered into the database due to the sporadic nature of these fisheries.

Mañāhak *en masse* recruitment events are predicted to occur up to three times a year for approximately 1 week, depending on the overall size of the run. Recruitment events are expected to occur the day of or days following the fourth, fifth, and tenth last quarter moon phase. Achemsom recruitments are irregular, but have been significant in terms of island-wide total harvest in certain years and usually recruit with mañāhak when they occur.

Atulai migrate into inshore areas throughout the year, which may cover a period lasting up to nine months. They usually enter protected locations, e.g., bays and channels, at daybreak and swim into deeper water before evening. A significant portion of the annual

catch is not reported from this fishery because the larger net catches are sporadic and seldom appear on regular surveys.



Figure 1. Inshore Fisheries "Participation Survey" Route and Location Codes.

Ti'ao and i'e' recruit annually on reef flats and make up a large portion of the annual catch and effort. Ti'ao generally recruit within a few days of the May full moon and during strong recruitment years, pulses of new recruitment will also follow the June and July full moons. I'e' runs also follow the full moon starting in May and can continue after each full moon through November. It is speculated that continued recruitment may be linked to rainfall. Past recruitment events of these species have shown to be highly significant in terms of total catch, especially *Caranx ignobilis*, *C. melampygous*, *C. papuensis*, and *C. sexfasciatus* with hook and line, and *Mulloidides flavolineatus* and *M. vanicolensis* with cast net, when they occur.

The FY97 inshore harvest estimates were statistically expanded by a computer software package for Macintosh known as the Fourth Dimension database program (4D). The 4D program utilizes formulae described in the FY83 report (Project FW-2R-20, Sub-Project F, Study F-1, Job 2) to compile and expand inshore survey data for the fiscal year.

RESULTS

During FY97, the estimated inshore harvest for day, night, and seasonal fishing around Guam was 45.6 mt. Finfish accounted for 69% of total harvest or 31.6 mt (excluding mañâhak surveyed in May). The seasonal mañâhak and achemsom catch accounted for an estimated 7.1 mt in FY97. The total inshore catch (finfish and invertebrates, including the 29 June and 13 July mañâhak data) resulted from a total effort of 217,789 person-hours (ph) and 197,525 gear-hours (gh). Overall, approximately 0.19 kg/gh of fish were harvested in FY97 (Table 1).

CATCH

Hook and line fishing yielded the largest overall catch with 15.0 mt or 48% of the total finfish harvest. Cast netting was second with 7.8 mt or 25%, while gill netting was third with 6.3 mt or 20%, and other methods were fourth with 5.6 mt or 18% of the total harvest (Table 1).

The top three daytime methods accounted for approximately 93% of the daytime total and 75% of the combined total harvest (Table 2). Hook and line fishing accounted for the most fish with 11.8 mt or 46% of the day harvest. Cast netting was second with 7.6 mt or 30%, while gill netting was third with 4.5 mt or 18%, and snorkel spearfishing was fourth with 1.0 mt or 4% of the total day finfish harvest.

The top three nighttime methods accounted for approximately 98% of the night total and 20% of the combined total harvest (Table 3). Hook and line fishing accounted for the most fish caught with 3.2 mt or 50% of the total night harvest and snorkel spearfishing was second with 1.7 mt or 27%. Gill netting was third with 1.4 mt or 21% and drag netting was fourth with 0.9 mt or 1% of the total night finfish harvest.

EFFORT

Hook and line fishing was the most practiced fishing method based on the total participation (Table 1), accounting for 44,744 persons or approximately 65% of the total participation. Cast netting was the second most practiced method overall accounting for 10,055 participants or 15% of the total participation, while gill netting followed in third with 7,637 participants or 11% of the total participation.

The rank order for day fishing participation placed hook and line first with 30,180 or 61% participants. Cast netting and gill netting placed second and third respectively with 9,989 or 20% and 5,628 or 11% of the participants (Table 2). Hook and line fishing remained the most practiced night fishing method with 14,593 participants or 77% of night participation. The second most practiced method was gill netting with 2,009 participants or 11%, while other methods followed in third with 1,668 participants or 3% of night participation (Table 3).

CATCH PER UNIT EFFORT (CPUE)

Other methods had the highest daytime CPUE of 2.12 kg/gh for weekday fishing and gill netting followed in second with 0.87 kg/gh. Snorkel spear was third with 0.69 kg/gh

Table 1. Combined estimated inshore participation, effort, and total harvest (kg) for all methods during the day and night in FY97.

METHOD	Persons	Gears	Trips	Per-Hrs	Gear-Hrs	Catch	Finfish	Inverts	CPUE†
Hook & Line	44,774	44,158	26,003	156,509	154,829	15,012	14,913	99	0.15 wd
Cast Net	10,055	8,826	7,637	23,266	20,423	7,778	7,621	157	0.78 wen
Gill Net	7,637	3,581	2,411	28,839	13,548	6,258	5,901	357	0.87 wed
Surround Net	0	0	0	0	0	0	0	0	0.0
Spear Snorkel	2,829	2,455	1,222	5,863	5,036	3,374	2,771	603	0.84 wn
Spear SCUBA	36	36	32	37	37	39	37	2	1.32 wen
Drag Net	175	32	32	292	53	87	87	0	1.67 wn
Hooks & Gaffs	519	665	333	976	1,177	307	0	307	0.28 wd
Other††	2,323	2,323	1,266	3,910	3,910	5,626	773	4,853	2.12 wd
TOTAL	68,348	62,076	38,936	219,692	199,013	38,481	31,560	5,925	0.19

†CPUE summary derives the greatest weekday (wd), weeknight (wn), weekend day (wed), or weekend night (wen) values from Tables 2 and 3. The greatest CPUE value for hook and line was in region 3.

††Other Methods usually include: gleaning, hand nets, traps, and spears.

Table 2. Estimated inshore participation, effort, and total harvest (kg) for all methods during the day in FY97.

METHOD	Persons	Gears	Trips	Per-Hrs	Gear-Hrs	Catch	Finfish	Inverts	CPUE†
Hook & Line	30,180	30,148	18,824	112,384	112,494	11,771	11,675	96	0.15 wd
Cast Net	9,989	8,759	7,570	23,147	20,303	7,742	7,585	157	0.54 wd
Gill Net	5,628	2,660	1,605	23,229	10,966	4,853	4,534	319	0.87 wed
Surround Net	0	0	0	0	0	0	0	0	0.0
Spear Snorkel	1,348	1,063	616	3,026	2,357	1,432	1,027	405	0.69 wed
Spear Scuba	0	0	0	0	0	0	0	0	0.0
Drag Net	0	0	0	0	0	0	0	0	0.0
Hooks & Gaffs	519	665	333	976	1,177	307	0	307	0.28 wd
Other††	1,668	1,668	912	2,675	2,675	4,610	773	3,837	2.12 wd
TOTAL	49,332	44,963	29,860	165,437	149,972	30,715	25,594	5,121	0.20

†CPUE summary derives the greatest weekday (wd) and weekend day (wed) values. The greatest CPUE value for hook and line was in region 3.

††Other Methods usually include: gleaning, hand nets, traps, and spears.

(Tables 1 and 2). Drag netting had the highest nighttime CPUE of 1.67 kg/gh for weeknight fishing and SCUBA spearfishing followed in second with 1.32 kg/gh. Snorkel spearfishing was third with 0.84 kg/gh (Tables 1 and 3).

The information concerning effort and harvest for methods not discussed are included in the summary Tables 1-3. Other nearshore fisheries harvests on Guam, including snorkel and SCUBA spearfishing off berthed and trailered boats, were recorded in the FY97 Offshore Fisheries Report (Study F-1, Job 1).

Table 3. Estimated inshore participation, effort, and total harvest (kg) for all methods during the night in FY97.

METHOD	Persons	Gears	Trips	Per-Hrs	Gear-Hrs	Catch	Finfish	Inverts	CPUE†
Hook & Line	14,593	14,010	7,179	44,124	42,335	3,240	3,237	3	0.12 wn
Cast Net	66	66	66	120	120	36	36	0	0.78 wen
Gill Net	2,009	921	806	5,610	2,582	1,404	1,366	38	0.63 wn
Surround Net	0	0	0	0	0	0	0	0	0.0
Spear Snorkel	1,481	1,392	606	2,837	2,679	1,942	1,744	198	0.84 wn
Spear SCUBA	36	36	32	37	37	39	37	2	1.32 wen
Drag Net	175	32	32	292	53	87	87	0	1.67 wn
Hooks & Gaffs	0	0	0	0	0	0	0	0	0.0
Other††	655	655	354	1,235	1,235	1,017	1	1,016	0.14 wd
TOTAL	19,015	17,112	9,075	54,255	49,041	7,765	6,508	1,257	0.16

†CPUE summary derives the greatest weeknight (wn) and weekend night (wen) values. The greatest CPUE value for hook and line was in regions 1 and 2.

††Other Methods usually include: gleaning, hand nets, traps, and spears.

SPECIES COMPOSITION

Species and Family Harvests

The expanded species composition for the FY97 expanded harvest for combined, day, and night efforts were calculated for FY97. The top non-seasonal reef fish species caught was the bluespine unicornfish, *Naso unicornis*, with 3.7 mt or 12% and *Caranx i'e'* was the top seasonal species caught, with 1.1 mt or 3.41% of the overall finfish total (Table 4). Acanthuridae was the top family of finfish harvested, with 7.1 mt or 22.46% of the combined harvest in FY97.

The top day species for seasonal and non-seasonal remained the same with *Naso unicornis* accounting for 3.3 mt or 12.99% (96% by hook and line, 3% by cast net, and 1% by gill net) and *Caranx i'e'* with 0.8 mt or 3.05% for the day finfish total (Table 5). Acanthuridae remained the top family for day, with 6.3 mt or 24.55% of the finfish harvest.

Selar crumenophthalmus was the top seasonal species caught for night, with 0.8 mt or 12.19% and *Naso unicornis* was second for night, with 0.4 mt or 5.53% of the finfish total (Table 6). Carangidae was the top family for night with 1.7 mt or 25.37% of the finfish harvest.

SCUBA spearfishing did not account for a significant amount of fish caught during the survey period, despite the high catch rate (personal observation) using this method. One reason for this occurrence is that a small percentage of SCUBA spearfishermen shore-dive at any given time, making it difficult to encounter them during an inshore catch survey. The greatest number of SCUBA spear interviews were obtained during the offshore survey (Study F-1, Job 1) in FY97.

The seasonal catch of certain juvenile fishes is widely anticipated by local fishermen. The FY97 catches of ti'ao and i'e' were well represented within the expansion estimates (Tables 4-6), especially *Caranx i'e'*. During FY97, pulses of recruiting ti'ao and i'e' occurred from June - September. I'e' (*Caranx* spp.) and ti'ao (*Mulloidés flavolineatus*)

ranked sixth and seventh of the day harvest respectively (Table 5) and i'e' ranked third (Table 6) for the night harvest in FY97.

Table 4. FY97 combined day and night catch composition for the top ten species and families of finfish harvested. Juvenile *Caranx ignobilis*, *C. melampygous*, *C. papuensis*, and *C. sexfasciatus* (i'e' ≤ 200 mm), *Mulloides flavolineatus* (ti'ao ≤ 100 mm), and *Siganus spinus* (mañâhak), are listed separately from the intermediate to adult size classes. Finfish harvest percentages were derived from the total day and night catch (31,560 kg).

SPECIES	Harvest		FAMILY	Harvest	
	kg	%		kg	%
<i>Naso unicornis</i>	3,683.56	11.67	Acanthuridae	7,087.78	22.46
<i>Siganus spinus</i>	2,592.00	8.21	Carangidae	4,657.41	14.76
<i>Acanthurus triostegus</i>	2,043.76	6.48	Siganidae	3,805.50	12.06
<i>Lethrinus harak</i>	1,203.76	3.81	Lethrinidae	2,125.74	6.74
<i>Caranx i'e'</i>	1,074.77	3.41	Mugilidae	1,943.74	6.16
<i>Liza vaigiensis</i>	1,008.17	3.19	Mullidae	1,876.29	5.95
<i>Selar crumenophthalmus</i>	958.25	3.04	Lutjanidae	1,405.23	4.45
<i>Mulloides ti'ao</i>	811.45	2.57	Gerreidae	1,076.28	3.41
<i>Mulloides flavolineatus</i>	788.01	2.50	Labridae	1,062.71	3.37
<i>Caranx ignobilis</i>	653.37	2.07	Scaridae	812.49	2.57
TOTAL ANNUAL COMBINED CATCH	14,817.10	46.95		25,853.17	81.92

Table 5. FY97 combined day catch composition for the top ten species and families of finfish harvested. Juvenile *Caranx ignobilis*, *C. melampygous*, *C. papuensis*, and *C. sexfasciatus* (i'e' ≤ 200 mm), *Mulloides flavolineatus* (ti'ao ≤ 100 mm), and *Siganus spinus* (mañâhak), are listed separately from the intermediate to adult size classes. Finfish harvest percentages were derived from the total day catch (25,594 kg).

SPECIES	Harvest		FAMILY	Harvest	
	kg	%		kg	%
<i>Naso unicornis</i>	3,323.83	12.99	Acanthuridae	6,282.97	24.55
<i>Siganus spinus</i>	2,256.10	8.81	Siganidae	3,401.79	13.29
<i>Acanthurus triostegus</i>	1,815.35	7.09	Carangidae	3,006.59	11.75
<i>Liza vaigiensis</i>	969.82	3.79	Mugilidae	1,815.20	7.09
<i>Lethrinus harak</i>	966.25	3.78	Mullidae	1,637.66	6.40
<i>Caranx i'e'</i>	780.53	3.05	Lethrinidae	1,561.77	6.10
<i>Mulloides ti'ao</i>	773.74	3.02	Lutjanidae	919.19	3.59
<i>Mulloides flavolineatus</i>	663.45	2.59	Gerreidae	868.31	3.39
<i>Caranx ignobilis</i>	596.04	2.33	Labridae	862.67	3.37
<i>Dussumieria spp.</i>	568.42	2.22	Clupeidae	568.42	2.22
TOTAL ANNUAL DAY CATCH	12,713.53	49.67		20,924.57	81.76

Table 6. FY97 combined night catch composition for the top ten species and families of finfish harvested. Juvenile *Caranx ignobilis*, *C. melampygous*, *C. papuensis*, and *C. sexfasciatus* (i'e' ≤ 200 mm), *Mulloidies flavolineatus* (ti'ao ≤ 100 mm), and *Siganus spinus* (mañahak), are listed separately from the intermediate to adult size classes. Finfish harvest percentages were derived from the total night catch (6,508 kg).

SPECIES	Harvest		FAMILY	Harvest	
	kg	%		kg	%
<i>Selar crumenophthalmus</i>	793.37	12.19	Carangidae	1,650.82	25.37
<i>Naso unicornis</i>	359.73	5.53	Acanthuridae	804.81	12.37
<i>Siganus spinus</i>	335.90	5.16	Lethrinidae	563.97	8.67
<i>Caranx i'e'</i>	294.24	4.52	Lutjanidae	486.04	7.47
<i>Lethrinus harak</i>	237.51	3.65	Siganidae	403.71	6.20
<i>Caesio caeruleaurea</i>	230.93	3.55	Scaridae	310.78	4.78
<i>Lutjanus argentimaculatus</i>	228.64	3.51	Holocentridae	278.86	4.28
<i>Acanthurus triostegus</i>	228.41	3.51	Mullidae	238.63	3.67
<i>Gerres acinaces</i>	195.67	3.01	Caesionidae	235.57	3.62
<i>Caranx sexfasciatus</i>	191.51	2.94	Gerreidae	207.97	3.20
TOTAL ANNUAL NIGHT CATCH	3,095.91	47.57		5,181.16	79.61

Method Harvests

The top harvest of finfish species for hook and line method was calculated for FY97 (Table 7). *Naso unicornis* ranked first for day, with 3.2 mt (27.42%) and the top seasonal species went to *Caranx i'e'* (ranked sixth), with 0.6 mt (4.74%). The first and second ranked finfish species were the seasonal *Selar crumenophthalmus* and *Caranx i'e'*, with 0.8 mt (24.51%) and 0.3 mt (8.10%) respectively and the river snapper, *Lutjanus argentimaculatus*, was the top non-seasonal species for night, with 0.2 mt (6.82%) of the total hook and line harvest.

The top harvest of finfish species for gill net method was calculated for FY97 (Table 8). The scribbled rabbitfish, *Siganus spinus*, ranked first for day, with 0.7 mt (14.39%), while the scissor-tailed fusilier, *Caesio caeruleaurea*, ranked first at night, with 0.2 mt (14.45%). No seasonal finfish ranked in the top-ten for gill net harvest in FY97.

The top harvest of finfish species for snorkel spear method was calculated for FY97 (Table 9). *Siganus spinus* ranked first for day, with 0.1 mt (13.88%), while *Naso unicornis* ranked first for night, with 0.4 mt (20.62%).

Seasonal Harvests

FY97 marked a good recruitment year for mañahak (ha'tang or *Siganus spinus* and lessor' or *S. argenteus*). Runs occurred 31 May - 3 June, 29 - 31 June and 13 July with a total estimated catch of 7.1 mt. The achemsom run occurred 29 - 31 June with an estimated catch of 2.5 mt in FY97. As of June 1997, DAWR suspended the collection of mañahak harvest data. The decision was made by upper management to avoid potential conflicts between fishermen and data collectors during this popular fishing event. Seasonal harvests of mañahak were manually expanded for 31 May - 3 June and included in the inshore expansion on 29 June and 13 July (Table 10).

Table 7. FY97 day and night catch composition for the top ten species of finfish harvested by hook and line method. Juvenile *Caranx ignobilis*, *C. melampygous*, *C. papuensis*, and *C. sexfasciatus* (i'e' ≤ 200 mm) are listed separately from the intermediate to adult size classes. Finfish harvest percentages were derived from the total day (11,675 kg) and night (3,237 kg) hook and line catch.

Day Species	Harvest		Night Species	Harvest	
	kg	%		kg	%
<i>Naso unicornis</i>	3,201.01	27.42	<i>Selar crumenophthalmus</i>	793.37	24.51
<i>Lethrinus harak</i>	751.81	6.44	<i>Caranx i'e'</i>	262.07	8.10
<i>Liza vaigiensis</i>	674.69	5.78	<i>Lutjanus argentimaculatus</i>	220.91	6.82
<i>Caranx ignobilis</i>	596.04	5.11	<i>Abedefduf sexfasciatus</i>	182.31	5.63
<i>Caranx melampygous</i>	566.75	4.85	<i>Caranx sexfasciatus</i>	178.83	5.52
<i>Caranx i'e'</i>	553.85	4.74	<i>Lethrinus harak</i>	159.26	4.92
<i>Decapterus macrosoma</i>	459.73	3.94	<i>Lethrinus xanthochilus</i>	142.54	4.40
<i>Aprion virescens</i>	417.84	3.58	<i>Lutjanus fulvus</i>	140.57	4.34
<i>Siganus spinus</i>	349.64	2.99	<i>Decapterus macrosoma</i>	97.86	3.02
<i>Chielio inermis</i>	307.24	2.63	<i>Lutjanus monostigmus</i>	73.39	2.27
Total Top Ten Hook & Line Catch	7,878.60	67.48		2,251.11	69.54
Total Combined Hook & Line Catch	10,129.71	67.93			

The atulai (*Selar crumenophthalmus*) season was moderately successful with 1.0 mt or 3% of the total catch for FY97. The total inshore harvest of atulai (100% of day and night harvest) were caught with hook and line, due to the high incidence of catch interviews at the Agana Boat Basin channel (Fig. 1, location 9 and Table 7).

Table 8. FY97 day and night catch composition for the top ten species of finfish harvested by gill net method. Juvenile *Caranx ignobilis*, *C. melampygous*, *C. papuensis*, and *C. sexfasciatus* (i'e' ≤ 200 mm), *Mulloides flavolineatus* (ti'ao ≤ 100 mm), and *Siganus spinus* (mañahak), are listed separately from the intermediate to adult size classes. Finfish harvest percentages were derived from the total day (4,534 kg) and night (1,366 kg) gill net catch.

Day Species	Harvest		Night Species	Harvest	
	kg	%		kg	%
<i>Siganus spinus</i>	652.32	14.39	<i>Caesio caerulea</i>	197.40	14.45
<i>Gerres oblongus</i>	550.87	12.15	<i>Leiognathus equulus</i>	172.39	12.62
<i>Valamugil seheli</i>	321.83	7.10	<i>Gerres acinaces</i>	171.79	12.58
<i>Mulloides flavolineatus</i>	323.72	7.14	<i>Acanthurus triostegus</i>	150.61	11.03
<i>Liza vaigiensis</i>	289.48	6.38	<i>Mulloides flavolineatus</i>	91.85	6.72
<i>Crenimugil crenilabis</i>	218.38	4.82	<i>Crenimugil crenilabis</i>	75.88	5.55
<i>Acanthurus triostegus</i>	195.68	4.32	<i>Lethrinus harak</i>	58.33	4.27
<i>Gerres acinaces</i>	188.48	4.16	<i>Siganus spinus</i>	48.23	3.53
<i>Myripristis murdjan</i>	185.50	4.09	<i>Diodon hystrix</i>	42.27	3.09
<i>Caranx papuensis</i>	175.44	3.87	<i>Siganus randalli</i>	41.09	3.01
Total Top Ten Gill Net Catch	3,101.70	68.41		1,049.84	76.86
Total Combined Gill Net Catch	4,151.54	70.35			

Table 9. FY97 day and night catch composition for the top ten species of finfish harvested by snorkel spear method. Finfish harvest percentages were derived from the total day (1,027 kg) and night (1,744 kg) snorkel spearfish catch.

Day Species	Harvest		Night Species	Harvest	
	kg	%		kg	%
<i>Siganus spinus</i>	142.55	13.88	<i>Naso unicornis</i>	359.58	20.62
<i>Acanthurus triostegus</i>	90.21	8.78	<i>Siganus spinus</i>	280.52	16.08
<i>Cheilinus trilobatus</i>	62.64	6.10	<i>Cheilinus trilobatus</i>	122.56	7.03
<i>Lutjanus fulvus</i>	43.31	4.22	<i>Epinelphelus merra</i>	96.44	5.53
<i>Diodon hystrix</i>	39.45	3.84	<i>Naso lituratus</i>	84.21	4.83
<i>Synanceia verrucosa</i>	39.45	3.84	<i>Acanthurus triostegus</i>	75.24	4.31
<i>Scarus sordidus</i>	29.85	2.91	<i>Scarus psitticus</i>	68.65	3.94
<i>Scarus psittacus</i>	27.66	2.69	<i>Scarus ghobban</i>	57.19	3.28
<i>Lethrinus harak</i>	22.53	2.19	<i>Parupeneus barberinus</i>	45.47	2.61
<i>Epinelphelus merra</i>	12.14	1.18	<i>Naso tuberosus</i>	39.93	2.29
Total Top Ten Spear Snorkel Catch	509.79	100.00		1,229.79	70.52
Total Combined Spear Snorkel Catch	1,739.58	62.78			

Table 10. FY97 maññhak harvest from 31 May to 3 June, 1997 (maññhak survey) and 29 June to 13 July, 1997 (inshore creel survey and incidental information). Catch data (kg) was obtained from the following locations: Adelupe; Asanite'; E. Agaña Bay; Gâdao-Fofos; Gun Beach; Ipan; Jones Beach; Pago Bay; Piti Channel; Tagachan Beach; and Tumon Bay.

Maññhak Survey

Method	Persons	Gears	Gear-Hrs	Catch	CPUE
				kg	kg/gh
CN	149	123	336	911	2.71
SN	16	7	27	308	11.41
TOTAL	165	130	363	1,219	14.12

Inshore Creel Survey

Method	Catch
	kg
CN	792
OM	133
TOTAL	925

Maññhak and Achemsom Harvest

Species	Catch
	kg
Maññhak	2,500
Achemsom	2,500
TOTAL	5,000

Invertebrates Harvested

In addition to finfish, a significant number of marine invertebrates were harvested from Guam's reefs. An estimated 0.8 mt of octopus (13% of the total invertebrate harvest) were caught island-wide in FY97. Daytime octopus harvests accounted for 0.7 mt (17% by gill net, 37% by snorkel spear, and 46% by hooks and gaffs), while nighttime harvests accounted for 0.1 mt (100% by snorkel spear) in FY97.

Sea cucumbers topped the list of harvested invertebrates with a day and night island-wide harvest of 1.7 mt (100% by gleaning) and included the following species: *Bohadschia argus* (0.09 mt), *Holothuria* spp. (0.2 mt), *H. atra* (0.6 mt), *H. leucospilota* (0.5 mt), and *Stichopus horrens* (0.4 mt), which amounted to approximately 29% of the total invertebrate harvest in FY97. The third most caught invertebrate was the giant spider conch, *Lambis* spp., with an estimated 0.34 mt (6% of the total invertebrate harvest) in FY97. Harvests of crustaceans accounted for an estimated 0.6 mt of spiny lobster, slipper lobster, mangrove crab, reef, and swimming crabs harvested in FY97.

Other methods, e.g., gleaning, crab trapping, and hand netting, produced an estimated 5.6 mt of finfish and invertebrates, e.g., *Dussumieria* and *Holothuria*, with a catch rate of 0.2 kg/ph of fishing effort.

Fishable Index Hours (FIH)

The FIH default is a parameter used in the expansion to identify the amount of time a person can fish with a particular method during a survey day (Table 12). Windows of survey fishable time includes: the a.m. (0600-1200 hours), p.m. (1900-2400 h), whole day (0600-1800 h), and whole night (1900-0200 h). The FIH is determined by dividing the survey fishable time by the whole day fishable time for each method. Fishable hours for each method are determined by the state of the tide. Some methods are not restricted by tide, e.g. hook and line and spearfishing. Net fishing is limited to tides above 0.5 ft., while hooks and gaffs for octopus and other methods are limited to tides below 0.5 ft (Table 11)

Table 11. Fishable Index Hours (FIH). Methods are listed as follows: Hook and Line (HL); Cast, Gill, Surround, and Drag Nets (N); Snorkel and SCUBA spear (SP); Hooks and Gaffs (HG); and Other Methods (OM), are listed for day and nighttime values for FY97.

Daytime FY97 FIH Values

Method	Oct	Nov	Dec	Jan	Feb	Mar	April	May	June	July	Aug	Sep
HL	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
SP	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
OM	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
N	2.40	2.20	2.20	2.20	2.20	2.10	2.00	2.20	1.76	2.25	1.80	2.60
HG	1.00	1.00	1.00	1.00	1.00	1.50	2.00	1.00	3.38	1.50	3.00	1.00

Nighttime FY97 FIH Values

Method	Oct	Nov	Dec	Jan	Feb	Mar	April	May	June	July	Aug	Sep
HL	1.40	1.40	1.40	1.40	1.40	1.40	1.40	1.40	1.40	1.40	1.40	1.40
SP	1.40	1.40	1.40	1.40	1.40	1.40	1.40	1.40	1.40	1.40	1.40	1.40
OM	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
N	1.31	1.54	1.44	0.98	2.13	1.88	1.92	1.63	1.50	1.50	1.50	1.44
HG	1.75	1.54	2.56	2.13	2.10	1.13	1.00	1.00	1.00	1.00	1.00	1.25

RECOMMENDATION

Since approximately 22% of the participants and gear-units are not surveyed on the inshore participation route (based on FY97 data), it is recommended that the aerial surveys be continued. The sampling technique has improved since the initiation of the aerial surveys and an improved quantitative analysis has been completed for island-wide inshore fishing effort.

Considering the inshore fisheries survey provides information important for management and planning, it is recommended that this job be continued. Due to the inadequacies of the "inshore-catch" survey window (especially nighttime for certain methods), harvests were not representative of the actual participation and includes the following methods for day: surround net, spear SCUBA, drag net and other methods; and night: cast net, surround net, hooks and gaffs, drag net, and other methods. Methods encountered more frequently, i.e., hook and line, cast net (day only), gill net, spear snorkel, spear SCUBA (night only), and hooks and gaffs (weekend day only), had confidence intervals less than 33% for daytime and less than 28% for nighttime fishing activity.

The increased availability and affordability of certain fishing gear methods has also changed on Guam. Hook and line has shown a significant increase since the early 1980's and has grown in popularity, especially with the i'e' and atulai fishery. Gill net use has remained high over the last decade, but the poor quality and disposability of the cheaper nets has created a situation of "ghost-netting" on our reefs. It is recommended that an increase in net dimensions, decrease in fishing time, and reduction in net length be made in order to reduce the overall destructiveness of this method. Inshore data compiled since 1985 supports the need for gill net restrictions with the alarming reduction of some species from the catch estimates.

Snorkel spearfishing has decreased in many inshore locations as a result of reduced fish stocks. Several species of parrotfish, i.e., *Scarus microrhinos* and *S. rubroviolaceus*, once common in the creel survey, have disappeared in favor of the smaller and more abundant species of parrotfish, e.g., *Scarus sordidus* and *S. psitticus*. It is the division's intention to protect many of the species of fish impacted by this and other methods through the implementation of the marine preserves.

SCUBA spearfishing has also increased with the aid of depth finders, bang sticks, and greater volume airtanks. It is recommended for equipment restrictions be placed on spear SCUBA, e.g., banning of bang sticks and high volume air tanks, in order to safeguard the rapid decline of our adult reef fish.

Overall declines in annual harvests and shifts in species composition have been documented in the last thirteen fiscal years. With the recent legislative approval of marine preserves and the implementation of new fishing regulations, we can begin to manage

destructive fishing methods and preserve critical areas for reef fishes to mature and reproduce. As the success of the marine preserves are documented over the next few years, the evidence needed to restrict the most destructive methods, e.g. gill nets and SCUBA spearfishing, will be possible. In addition, the marine preserves will decrease the survey locations and will require the addition of new ones, e.g. location 91, and 92 to region I; 35 to region II; and, 39 and 73 to region III, (Fig. 1) for the inshore survey.

The future status of our fishery will depend on the overall success of these management techniques to conserve and protect this essential resource for generations to come.

PROJECT COST

The estimated cost of this project was \$100,000.

Report prepared by: Todd J. Pitlik

APPENDIX 1

INSHORE AERIAL SURVEY

PERIOD COVERED: October 1, 1996 to September 30, 1997

SUMMARY

A total of 20 "inshore aerial" surveys were conducted in FY97 for a total of 1,034 persons and 915 gear units. Hook and line was the most frequently encountered method with 614 persons and 603 gear units. A ratio of participants / method observed in areas outside the inshore participation route to the total number for all methods surveyed during the "inshore aerial" were calculated as variables (P_2 values) for the inshore expansion. The values ranged from 63% for weekday cast net and weekend snorkel spear to 100% for rare and night-practiced methods, e.g., surround net, drag net, and SCUBA spear fishing.

Incidental biological sightings resulted in a total of 170 turtles, 14 pods of dolphins, 1 pod of pilot whales, 19 sharks, 7 eagle rays, and 4 sting rays for FY97.

BACKGROUND

Inshore fishing surveys have been conducted by the Division of Aquatics and Wildlife Resources (DAWR) since the early 1960's to monitor and collect a long-term database on the total fishing effort and catch from Guam's reefs. The "inshore-catch" and "inshore-participation" surveys were developed to collect catch and effort data in near-shore areas easily accessible by motor vehicle. In addition, the inshore-aerial survey was established in the early 60's and reinstated in FY90 to survey effort in areas that could not be easily accessed by a vehicle.

PROCEDURES

Inshore-aerial surveys were conducted twice monthly on regularly scheduled participation days (one weekday / weekend). Start times are moved up in one-hour intervals for each subsequent survey (0800-1200h), then repeated after reaching 1200h. Visual observations of areas not covered in the "inshore-participation" survey (Fig.1 locations: 18, 22, 27, 28, 35-39, 44-50, 54, 55, 58, 59, 70, and 73-92) included fishing effort data. The first scheduled weekday and weekend participation survey dates of each month were selected to allow rescheduling in the event of poor weather conditions.

Each survey started in location 11 and proceeded in a clockwise direction all the way around the island to location 12 (Fig. 1). The seaward flight distance from the reef margin was 200-300m with an altitude of 170-200m. The aerial itinerary also included a semi-circular flight pattern within Cocos Lagoon and Apra Harbor. In addition, the pilot was instructed to circle over reef flat areas when it was difficult to observe or determine activity.

The aerial survey observations were sorted by method and type day (weekday / weekend). A ratio of the persons / method observed in areas outside the inshore participation route were compared to the total number of persons / method observations for the island for

each type day. The resultant P_2 values provided variables (%) that could be used to expand inshore participation values to island-wide participation values.

Other biological data collected, included incidental observations of marine mammals, turtles, sharks, and rays at or near the surface of various reef zones, e.g., Pauliluc Bay and the fore reef slope, along the aerial survey route.

The FY97 inshore harvest estimates were statistically expanded by a computer software package for Macintosh known as the Fourth Dimension database program (4D). The 4D program utilizes formulae described in the FY83 report (Project FW-2R-20, Sub-Project F, Study F-1, Job 2) to compile and expand inshore survey data for the fiscal year.

RESULTS

The most frequently encountered methods included hook and line, cast net, gill net, snorkel spear, hooks and gaffs, and other methods, while surround net, SCUBA spear, and drag net methods were less common. Ratio frequencies were highest (100%) for the least common methods, which were due to the rarity of their use during the day, e.g., SCUBA spear and drag net are primarily night methods. Hook and line, cast net, gill net, surround net, snorkel spear, hooks and gaffs, and other methods (weekday and weekend days respectively) had P_2 values (Table 1) listed as percentages: (82 / 87), (63 / 76), (64 / 76), (100 / 100), (92 / 63), (100 / 68), and (79 / 79), respectively for FY97.

Table 1. P_2 values derived from aerial survey data in FY97. Ratios were calculated from a ratio of method sightings within aerial locations to participation locations. Methods abbreviations are listed as follows: Hook and Line (HL); Cast Net (CN); Gill Net (GN); Surround Net (SN); Spear Snorkel (SpSn); Spear SCUBA (SpSc); Hooks and Gaffs (HG); Drag Net (DN); and Other Methods (OM).

Ratios	HL	CN	GN	SN	SpSn	SpSc	HG	DN	OM
Weekday	37/168	16/27	16/29	0/4	1/11	0/0	0/2	0/0	4/15
Weekend	52/357	21/67	18/56	0/37	15/26	0/0	8/17	0/0	6/22
WD Ratio	168/205	27/43	29/45	4/4	11/12	0/0	2/2	0/0	15/19
WE Ratio	357/409	67/88	56/74	37/37	26/41	0/0	17/25	0/0	22/28
WD P_2	82	63	64	100	92	100	100	100	79
WE P_2	87	76	76	100	63	100	68	100	79

The greatest number of people fishing in participation areas during the aerial survey used hook and line on weekdays and weekends for a total of 525 and 517 persons and gear-units respectively, while hook and line was also the most frequently used method in aerial areas for a total of 89 and 86 persons and gear units respectively for FY97 (Table 2).

Dolphins topped the list of the most frequently sighted marine animals during the aerial surveys with 700 sightings. The greatest monthly total of 300 dolphin sightings occurred in June (Table 3). Turtle, pilot whale, and shark sightings ranked second, third, and fourth, respectively with annual totals (Table 3). The greatest monthly total of turtles were sighted in October, June, and August, with 29 and sharks in October with 9. The only month pilot whales were sighted was in September with 20. In addition, a total of 7 eagle rays (6 in Cocos Lagoon) and 4 stingrays were sighted in FY97 (Table 3).

Table 2. Total number of people and gear units observed during aerial surveys in FY97. Method abbreviations are listed in Table 1 with weekday (WD) and weekend (WE) days listed below.

Methods	Within Par Route				Outside Par Route			
	Persons		Gears		Persons		Gears	
	WD	WE	WD	WE	WD	WE	WD	WE
HL	168	357	165	352	37	52	34	52
CN	27	67	22	58	16	21	15	19
GN	29	56	16	25	18	18	9	8
SN	4	37	1	5	0	0	0	0
SpSn	11	26	11	26	1	15	1	15
SpSc	0	0	0	0	0	0	0	0
HG	2	17	2	24	0	8	0	8
OM	15	22	15	22	4	6	4	6
Total	256	582	232	512	76	120	63	108

Table 3. Number of turtle, dolphins, shark, and ray sightings by aerial surveys around Guam in FY97.

SPECIES	MONTHS												TOTAL
	O	N	D	J	F	M	A	M	J	J	A	S	
Turtle	29	6	10	7	3	22	11	9	29	7	29	8	170
Dolphin	190	0	10	0	15	0	0	0	300	0	10	175	700
Shark	0	0	0	0	0	0	0	0	0	0	0	20	20
Sting Ray	9	0	1	1	0	4	0	0	0	0	3	1	19
Eagle Ray	0	0	0	0	0	0	2	1	0	0	0	4	7
Manta Ray	2	0	0	0	0	0	0	0	0	0	0	2	4

Cancellations due to poor weather conditions, were a moderate problem in FY97. Four cancellations occurred on the following weekday (WD) and weekend (WE) survey dates: WD (11/22/96); and WE (1/18/97, 2/23/97, and 8/30/97).

FLIGHT COST

The cost of the project was \$9,500.

Report prepared by: Todd J. Pitlik

APPENDIX 2

KID'S FISHING DERBIES

PERIOD COVERED: 1 October, 1996 to 30 September, 1997

SUMMARY

A marine fishing derby for kids, event was co-sponsored by DAWR in FY97 in cooperation with Andersen Air Force Base. This two-day event, held at Tarague Channel, was open to 150 participants, or 75 kids per day. A total of 53 participants signed up for the two one-day fishing events. This was the eighth marine derby sponsored by the Department of Agriculture's Division of Aquatic and Wildlife Resources (DAWR). Andersen Air Force Base has co-sponsored four marine derbies with DAWR.

OBJECTIVES

To encourage fishing as a form of recreation for children by promoting at least two kids fishing derbies per fiscal year, and to use these events as opportunities to teach environmental and fishing conservation ethics.

PROCEDURES

Coordination and Logistics

Derby preparation and planning took at least 4-6 weeks in advance. A fishing site and potential date had to be selected, which provided safe shoreline for the participants and good habitat for fishing. Fishing dates required an a.m. high tide to increase the chances of catching fish.

Kid's fishing derbies held in cooperation with military installations had individuals from both agencies serving as points of contact. This ensured that requirements of both agencies were met and that duties assigned to each agency were completed. Chief Conservation Officer Dan Works of Andersen Air Force Base and DAWR Fisheries Biologist Veronica Cummings were the designated points of contact for this kid's derby.

Logistics included providing: rest areas with chairs and tables as well as refreshments, staff to serve as officials, organizing a safety briefing and the awards ceremony, and ensuring that official representatives from both agencies were present for the awards presentation. Certificates of Participation and fish posters were provided to all participants. A draft post-derby report has been completed, which includes comments and suggestions from derby participants to improve future derbies.

Advertisements

The advertising strategy employed intended to ensure maximizing derby exposure to children ages seven to twelve both on and off base. This was done by providing flyers to all elementary and middle schools, having highway banners displayed in strategic locations, providing the media with press releases periodically, and making derby pitches through various radio talk shows.

Derby Rules and Clinic

The derby had a harvest size limit and a bag limit for the fish caught to encourage the practice of conservation. Fish had to be over 6 inches (152 mm) in length in order to qualify for the derby awards and to be kept. Although there was an individual bag limit of five fish, participants were encouraged to practice "catch and release" during the event.

The derby was open to children from seven to twelve years of age, and was preceded by a fishing clinic open to the public on June 14, 1997. The fishing clinic provided an opportunity for parents and children to learn about and practice basic fishing skills including knot-tying and casting. Demonstrations were also conducted to aid parents in selecting and purchasing fishing gear and in preparing for the fishing event.

RESULTS

The derby was initially scheduled for June 7-8, but was rescheduled for the weekend of June 21-22 to avoid conflicting with another derby scheduled on the same day. This derby had the lowest number of registrants despite extending the registration period to June 18. Although only 53 participants signed up, the derby was kept to 2 days in order to ensure the best fishing opportunity. Thirty-nine children actually participated in the event.

Derby results are listed in Table 1. Prizes for the derby were solicited for a two-day event in accordance with Executive Order 91-08, resulting in thirty-seven prizes being donated. Since there were only six winners from the actual fishing, the remaining prizes were distributed by lottery to the non-winners. Food was also donated by businesses, with donuts and soft drinks being provided as refreshments.

Table 1. Kid's Derby Winners in FY97

MOST FISH on SATURDAY

First Place	Jadine Leonen	3 fish
Second Place	Charly Leonen	2 fish
Third Place	Matthew Paulino	2 fish

LONGEST FISH

First Place	Esther Cardenas	7.1" Honeycomb Grouper
-------------	-----------------	------------------------

LONGEST TRIGGERFISH

First Place	Tony Meno II	7.5" Wedge Picassofish
Second Place	Chelcy Reyes	7.4" Picassofish

MOST FISH on SUNDAY

First Place	John Pangelinan	4 fish
-------------	-----------------	--------

LONGEST FISH

First Place	Joseph Pangelinan	7.8" Lowfin Rudderfish
Second Place	Raymond Blas	7.3" Honeycomb Grouper

LONGEST TRIGGERFISH

First Place	Ariel Lozada	6.3" Picassofish
Second Place	Jay Horton	6.26" Wedge Picassofish

RECOMMENDATIONS

Evaluations and Comments

1. Just a big Thank-You to the dedicated and nice folks at the Department of Agriculture Division of Aquatic and Andersen Air Force for this activity. My son and I enjoyed the day. Ben Carbullido.
2. I am amazed with how well the whole activity is organized. For first-timers like my kids, it was truly a fun experience for them. This is really a good and encouraging activity for kids. Thanks to all those who braved the rains and who woke up very early to get this going. Marites Fojas.
3. Very good program by both the DOA and Andersen. Now if only we can get the fish to cooperate. Wil Paulino.
4. The Derby has been very well organized. We like the location - AAFB. Don't change anything. Felix Reyes.
5. Thanks, I think the program is great and you took care of everything imaginable. Thanks again. Chuck Talley.
6. Very Satisfactory. Kids enjoy themselves . Special Thanks.
7. This is the 5th Derby for my son and like always we really enjoyed ourselves. Hope that this event will continue for future generations.
8. Excellent job. I think the kids enjoyed it. Mages.
9. It was fun, good knowledge for everyone.
10. Great Fishing Derby. It should be done at 2x a year. It's good for the kids to look forward to.
11. The safety should be held before day of fishing so that kids can just go fishing upon arrival due to fishing upon arrival due to fish-feeding schedules. That's it. Albert Benavente.
12. This event provides a great opportunity and good excuse to take my boys fishing. I missed this clinic but I hope that future ones have specifics on bait and riggings for our area. This is our 3rd and will do all future ones. Jack Kuhn.
13. I don't know much about rod and reeling only that I take my kids whenever they want to go. But today's derby was nice and calm. I just hope next derby maybe, the older brothers may be allowed to help during the derby. Thanks !!! From all of us!
14. I think this is an excellent program and should be continued in the future. The DAWR did an excellent job at hosting the derby as well as the AAFB personnel. Thank You. John Jocson.
15. We got lots of bites but we didn't catch any fish. Alex D. Numann.
16. Hope to be here next year!

17. Not quite good catch today but it was a lot of fun. I believe that this program is beneficial to everyone, therefore, it should be continued. Also, give chance to the adult. Quilantip.
18. It was a good experience (Thank You). The boys learned a lot from the clinic and from the Derby. Jerome Quigley.
19. How about a new area for the derby - Ritidian? Would a late afternoon derby get more anglers/better participation? Good program.
20. I enjoy my fishing from the Agriculture sponsored. It's encouraging from a age like young people. It gives us good pleasure learning to be good fisherman. Tony Meno II.

The derby program has been well received and is a valuable educational tool for those who participate. However, an increase in the number of participants is essential for the program to effectively continue. This can be achieved by adding radio advertisements to our other methods of advertising. In addition, hosting more events and targeting special groups like the Boy Scouts, Girl Scouts, or village programs could work well.

Another factor concerning participation in derbies is to find a location that is more centrally located, instead of going to strictly military sites.

The response from participants and parents was positive. There have been requests by participants and parents to include a category for teenage anglers. Some of the older participants are interested in staying in the program, while some parents have older children who usually help their younger siblings to fish. This might help in making the derby more family oriented and decrease the chance of turning away potential participants.

PROJECT COST

The estimated cost of this project is \$1,000.

Report Prepared by: Veronica Cummings

JOB PROGRESS REPORT RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: F-1R-5
SUB-PROJECT NO.: F-2
STUDY NO.: 1
JOB NO.: 1

JOB TITLE: Freshwater Monitoring (2440)

PERIOD COVERED: October 1, 1996 to September 30, 1997

SUMMARY

During FY97, the four previously selected watersheds were sampled for a second year. Faunal counts and basic observations collected in FY96 and FY97 have been summarized. The tributaries above Fena Reservoir and the drainage below were assessed to determine the influence of the dam on migrating fauna. The results of the study were completed in FY97. Comparative analyses of the data collected during FY96-97 have been completed.

Five other streams were visited during FY97 and data collected were added to the database file started in FY96.

BACKGROUND

Maintenance of high quality watershed ecosystems, is essential to protecting healthy coastal areas that support fisheries. In order to maintain the quality of Guam's watershed ecosystems, baseline data must first be collected which includes identifying the aquatic species residing in these ecosystems, determining their densities, the physical characteristics of the streams, and the quality of the water. Monitoring these parameters will support watershed management and thus ultimately protect Guam's coastal resources.

Although various watersheds have been monitored for different parameters, in general Guam's freshwater resources are not well studied. The methods of monitoring have seldom been replicated, making comparisons or management as a whole unrealistic. In the past ten years the island has experienced a rapid economic growth and structural development. Some existing and proposed developments, such as golf courses/resorts, occupy large tracts of land with major watersheds. Little baseline data exists by which to assess potential impacts of proposed development on streams, lakes, and coastal areas and therefore impact assessment has been difficult without extensive study and mitigation recommendations. Some development projects initiated within the last 10 years have significantly degraded watershed quality, which has contributed to large losses of coral reef habitat. Additionally, much of the existing watershed work has been completed by off-island consultants over short intervals using techniques developed for temperate areas and not applicable in their entirety to Guam's tropical freshwater systems.

The work performed during FY97 was devoted to two projects started during FY96, which will be used to develop and implement a long-term watershed monitoring program. Four watersheds were selected at the beginning of FY96 for a short term monitoring program: 1) Fena; 2) Manenggon; 3) Ylig; and 4) Pago. These watersheds were selected because they represent a range of watershed characteristics that may help to determine the impacts of

the present and proposed land uses. The short-term objective of this project was to develop a technique to survey aquatic fauna to allow statistical comparisons within and between watersheds to establish a baseline database to monitor watershed health. It has been shown that visual surveys are effective in estimating fish abundance's in small streams (Hankin and Reeves, 1988; Moyle and Baltz, 1985) like the ones found on Guam. The Modified Point Quadrat method (Baker and Foster, 1992) is a survey protocol that has been used in Hawaii (Nishimoto and Kuamoo, 1991), Guam (Parham, 1995), and elsewhere in Micronesia (Parham, 1995; Nelson et al., 1995). The Modified Quadrat technique was field tested in 1995 in the selected watersheds and determined to be feasible for the initial FY96 study. This method was also used to survey the organisms found in each of the streams during FY97.

In addition to the watershed management issue a second aspect of this job was to address the concern over the impact that man-made lakes have on watersheds.

Several islands within Micronesia have plans to develop surface water resources through the construction of reservoirs. However, aspects of the region's inland aquatic ecosystems are poorly known, and reservoirs could present migration barriers and affect the distributions and densities of freshwater fauna in the streams that drain into them. The stream fauna of oceanic islands consists of a few species whose ancestors invaded from marine sources (Maciolek and Ford, 1987). All of the indigenous, non-insect macrofauna of the streams of Guam are diadromous, spending part of their life in the sea and part in freshwater (McDowall, 1991). Thus, for species to exist in streams above reservoirs, they must have access to the marine environment, especially during the migration periods of adults, juveniles, and larvae, and they must be able to pass through the reservoir on their upstream migration to the streams. If the reservoir is a barrier to fish migration, then the macrofauna communities in the streams above the reservoir could be structured differently with regard to species composition and densities. The reservoir and the dam could pose a barrier to diadromous animals making their way up to the streams above the reservoir for several reasons. The reservoir is home to several species of fish that could prey upon migrating larvae and juveniles. Also, while some of the gobioid fishes have specialized pelvic fins that allow them to traverse the spillway, others are not adapted to climbing. Third, when the spillway is dry, or conversely, if water is flowing too rapidly over the spillway, some species may not be able to get past the dam.

In the past the Department has reviewed proposals for the placement of dams in Guam's rivers. Unfortunately, adequate data was not available to assess the potential impacts such structures would have on the indigenous aquatic macrofauna. Instead, private consultants gathered data using survey techniques that had no been field tested to work in small tropical watersheds. Based on these past experiences, the need for consistent sampling protocols, and the need for baseline data (of aquatic macrofauna) it was decided to carry out a project to address these aspects.

This project is part of the initial study started in FY95. The three streams above Fena reservoir (the experimental streams) and four control streams were surveyed to test the Modified Quadrat technique (Figures 1 and 2). All seven rivers are part of the four watersheds selected for the initial study. If the reservoir blocks macrofauna migration, then species composition and densities would be different from the control streams and experimental streams.

This project also serves as a Master of Science thesis project for the program coordinator under the University of Guam's Graduate Biology Program.



Figure 1. Guam and expanded view of streams surveyed above and below the Fena Reservoir. The Almagosa, Maulap, and Sadog = Experimental Streams and the Maagas River = 1 of 4 Control Streams.



Figure 2. Guam and expanded view of control streams surveyed. The Manenggon, Pago, and Ylig = 3 of 4 streams surveyed.

OBJECTIVES

1. To compile both local and watershed information and relevant related literature available for Guam watersheds and the monitoring and management of such systems; and to develop a list of watershed information needs, prioritize needs and pursue separate program development to obtain needs.
2. Develop and test sampling/survey technique.
3. Collect baseline macrofauna, and other pertinent data on representative streams.
4. Determine the role of dams/reservoirs as barriers to reproduction of freshwater macrofauna.

PROCEDURES

A list of local watershed information and relevant literature available for Guam was collected both from local and off-island sources. Simultaneously, suitable monitoring techniques were also researched. This information was used to develop a scope of work for development and implementation of a long-term freshwater monitoring program. Four watersheds were selected for the initial monitoring program and the testing of a survey technique. Fena Reservoir and its tributaries are part of one of the watersheds chosen for the initial study.

Species composition and species density data was collected in the four selected watersheds using the Modified Quadrat technique. In addition species composition and species densities, several environmental parameters were measured to determine their role in the species composition of stream macrofauna and to gather information regarding the physical characteristics of the stream. The water velocity at each quadrat was measured in the center of the quadrat at 60% of the maximum depth. The readings taken during this period were averaged. A Flo-Mate portable flowmeter Model 2000 was used to measure water velocity and a wading rod was used to measure water depth. The two dominant substrate types and their percent makeup were recorded for each quadrat. The Helm, et al. (1985) classification system was used to categorize substrate types as either bedrock, boulder (>256 mm), cobble/rubble (64-256 mm), gravel (5-64 mm) or sand/sediment (<5 mm) by diameter.

A 200-m section of each stream was sampled, and the location within the stream was chosen haphazardly. The 200-m section was divided into twenty 10-m contiguous sections. Each 10-m segment was measured in a parallel line adjacent to the stream and then a number between 0 and 9 was drawn from a bag (0-9 as representing one meter segments along the transect, i.e., #4, would equal 5 meters measured along the 10-meter segment). Once the random location along the stream edge was selected, the position of the observation (whether on the left side, right side, or in the middle of the stream) relative to stream width was chosen.

Upon reaching the selected area, I chose a spot for viewing. This was done by locating objects (rocks or debris) within the stream to mark the corners of the rectangular quadrat. Because organisms may be disturbed by the observer moving into place, two minutes were allowed for them to settle back into the area prior to counts being made. Counts of fish and prawns were made from the stream bank or in the water with a snorkel and mask. The presence or absence of snail species was also noted. After all the organisms had been counted, a surveyor's tape was used to measure the length and width of each quadrat; from these measurements, the density (individuals per m²) of each species was determined.

To address the question of watershed impacts resulting from man-made dams or lakes, additional surveys were conducted within Fena Reservoir using snorkel and mask. The areas surveyed were along the banks of the reservoir that are shallow enough for the observer to see the bottom. Each species observed was recorded as being present.

When possible, analysis of variance was used for data comparison of the streams. However when the data did not conform to the assumptions for the ANOVA, the nonparametric, Kruskal-Wallis One-Way Anova for Ranks corrected for ties (SOLO 6.0, BMDP Statistical Software, Inc., Los Angeles, California U.S.A.), was used.

RESULTS

This report marks the first significant stream monitoring dry season data set collected on this project. The FY96 and FY97 data was summarized and analyzed and an artifact in the data became apparent. Quadrat sizes ranged from 0.4 to 2.6 m² and macrofaunal densities ranged from 0 to 35 organisms per m² (Figs. 3 to 8).

It is clear that for some species, as can be seen for the 1997 data for *Macrobrachium lar* (Fig. 6), higher densities were recorded in the smaller quadrats. With smaller quadrat sizes the frequency distributions resemble a Poisson distribution more than a normal bell-shaped curve. The result is that many quadrats have zero values, and with greater densities, a pattern where density is dependent on quadrat size is apparent. In 1997, the data collected were based on a much more uniform quadrat size. For most species the pattern seen in the 1996 data, was also seen in the 1997 data, which was taken using less variable quadrat sizes; the data for *Stiphodon elegans* is a possible exception (Figs. 7 and 8).

Species composition varied between streams (Table 1). The most obvious difference between the fauna of the experimental and control streams was the absence of nerite gastropods from the streams above the reservoir. One nerite gastropod was seen in 1996 along the spillway but never in any of the experimental streams or along the edges of the reservoir. The snail *Thiara granifera* was the only species of gastropod seen in the streams above the reservoir.

Most species were present in all of the streams. Four species occurred throughout all streams surveyed: the mountain goby *Stiphodon elegans* (Steindachner), the Guam goby *Awaous guamensis* (Valenciennes), the freshwater prawn *Macrobrachium lar* (Fabricius), and the eel *Anguilla marmorata* (Quoy and Gaimard). The streams above the reservoir had more species of fish than the control streams. This was primarily the result of the presence of cichlid fishes, e.g., *Tilapia zillii* (Gervais), *Tilapia mossambicus* (Peters), and *Cichla ocellaris* (Bloch and Schneider) that had been introduced to the reservoir (Nelson and Edredge, 1991). In addition, the goby *Mugilogobius cavifrons* (Weber) was found only in the streams above the reservoir but not in the control streams. Furthermore, this goby was not seen in the Maagas River, which is located below the reservoir's spillway. The flagtail *Kuhlia rupestris* (Lacepede) was present only in the control streams. *Sicyopus leprurus* occurred only in one of the control streams, the Manenggon River, and even there it was uncommon. The introduced cichlid, *C. ocellaris*, was seen below the dam in the Maagas River on only on one occasion. The number of species per unit area was different among streams both in 1996 ($F_{(6, 132)} = 4.15$, $p = 0.001$) and in 1997 ($F_{(6, 132)} = 9.36$, $p = 0.000$) (Figs. 9a.-b.). River definitions for figure 9 a-h (x-axis) are as follows: 1 = Alamagosa; 2 = Maulap; 3 = Sadog; 4 = Ylig; 5 = Manenggon; 6 = Pago; and 7 = Maagas; experimental streams = 1 – 3; control streams = 4 – 7; 25th percentile = zero (y-axis); 50th percentile (median) = line within box; 75th percentile = line farthest from zero; 10th and 90th percentiles = standard deviations; and circles = data outliers.

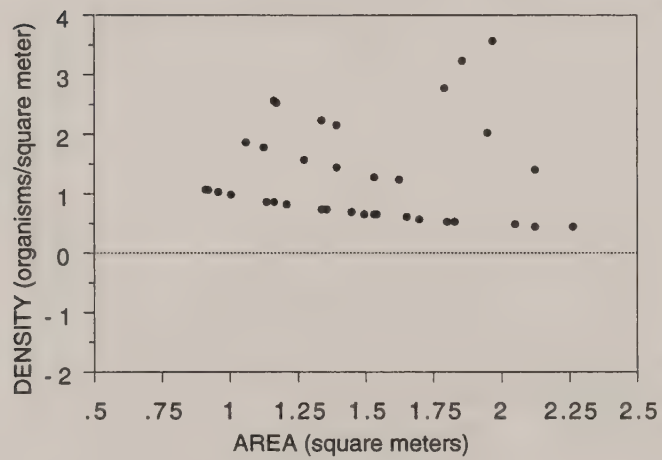
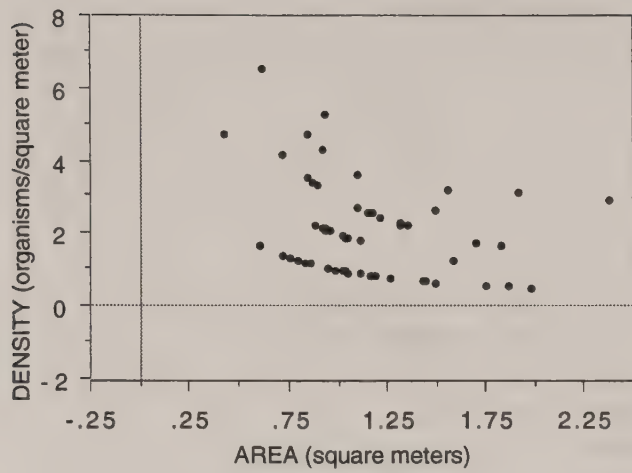


Figure 3. A plot of the Guam Goby, *Awaous guamensis*, densities on quadrat size for 1996.
 Figure 4. A plot of the Guam Goby, *Awaous guamensis*, densities on quadrat size for 1997.

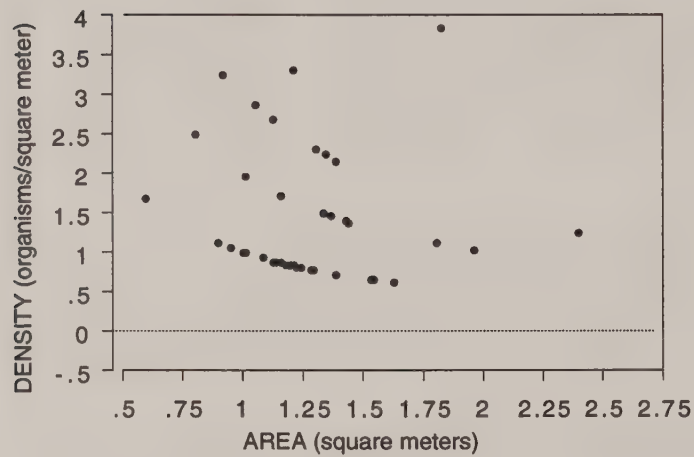
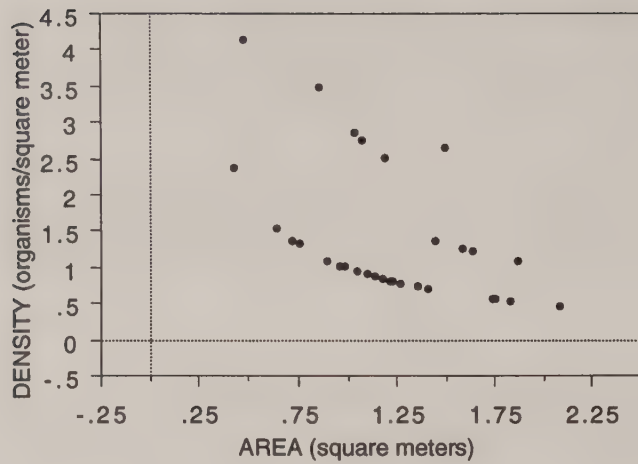


Figure 5. A plot of the Prawn, *Macrobrachium lar*, densities on quadrat size for 1996.

Figure 6. A plot of the Prawn, *Macrobrachium lar*, densities on quadrat size for 1997.

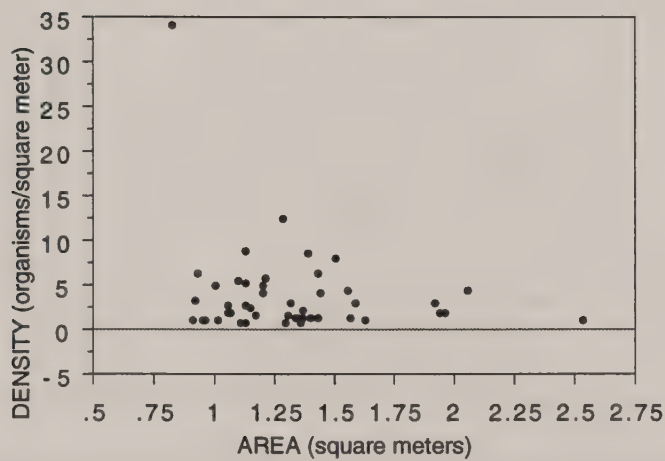
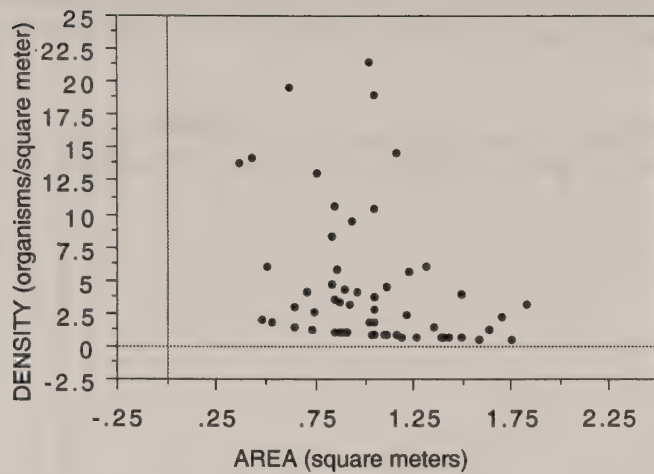


Figure 7. A plot of the Mountain Goby, *Stiphodon elegans*, densities on quadrat size for 1996.
 Figure 8. A plot of the Mountain Goby, *Stiphodon elegans*, densities on quadrat size for 1997.

Table 1. Species composition for all streams and Fena Reservoir. An "x" indicates a species is present in a stream and an empty cell indicates the absence of a species. The Maagas River is located below the Reservoir †.

SPECIES	Experimental Streams			Control Streams				†
	Almagosa	Sadog	Maulap	Maagas	Manenggon	Pago	Ylig	
Fish								
Gobiidae	x							
<i>Awaous guamensis</i>	x	x	x	x	x	x	x	x
<i>Stiphodon elegans</i>	x	x	x	x	x	x	x	x
<i>Mugilogobius cavifrons</i>	x	x	x					x
<i>Sicyopus leprurus</i>					x			
Cichlidae								
<i>Cichla ocellaris</i>	x	x	x	x				x
<i>Tilapia mossambicus</i>	x	x	x	x	x	x	x	x
<i>Tilapia zillii</i>	x	x	x	x	x	x	x	x
Kuhliidae								
<i>Kuhlia rupestris</i>				x	x	x	x	
Anguillidae								
<i>Anguilla marmorata</i>	x	x	x	x	x	x	x	x
Crustaceans								
Palaemonidae								
<i>Macrobrachium lar</i>	x	x	x	x	x	x	x	x
Gastropods								
Neritidae								
<i>Thiara granifera</i>	x	x	x	x	x	x	x	x
<i>Neritina pulligera</i>				x	x	x	x	x
<i>Neritina variegata</i>				x	x	x	x	x
<i>Neritina squamipicta</i>				x	x	x	x	x

Because the density data did not meet the assumptions of the ANOVA, the Kruskal-Wallis One-Way Comparison for ranks was used to test for differences in densities of individuals or particular species between streams. There was a significant difference in the densities of *Awaous guamensis* among streams in 1996 ($H = 57.3$, $p = 0$), but not in 1997 ($H = 10.0$, $p = 0.125$). Densities of *A. guamensis* (Figs. 9c.-d.) in the Manenggon River were much lower than in the control streams.

The 1996 and 1997 densities of *Stiphodon elegans* ($H=45.6$, $p=0.000$ and $H=44.2$, $p=0.000$, respectively) (Figs 9e.-f.) and *Macrobrachium lar* ($H = 21$, $p = 0.002$ and $H = 28.8$, $p = 0.0001$, respectively) differed significantly among streams (Figs. 9g.-h.). For both years, densities of *M. lar* were higher in the experimental streams than in any of the control streams. However, in 1997 the Manenggon River, one of the control streams, had higher densities of *M. lar* than the experimental streams.

The proportions of substrate types sampled varied from stream to stream for both 1996 and 1997 (Table 2). Some rivers had higher proportions of bedrock or sand than others. It appeared that certain species were found consistently within quadrats comprised of certain substrates. For example, *Stiphodon elegans* was sighted on harder substrates such as cobble and pebble whereas *Awaous guamensis* was more common on sand substrate.

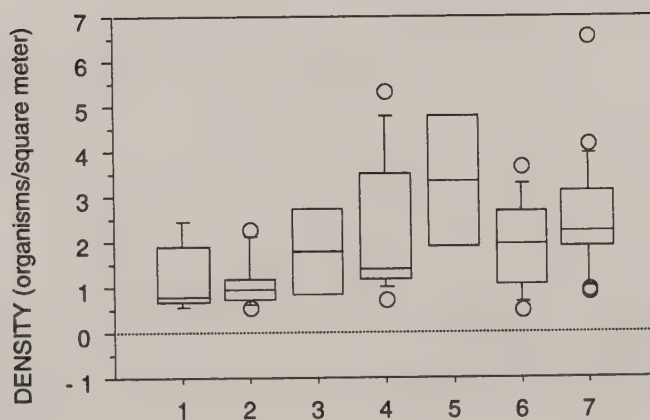
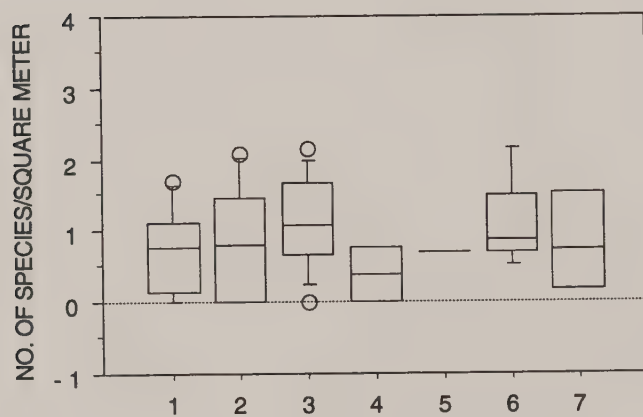
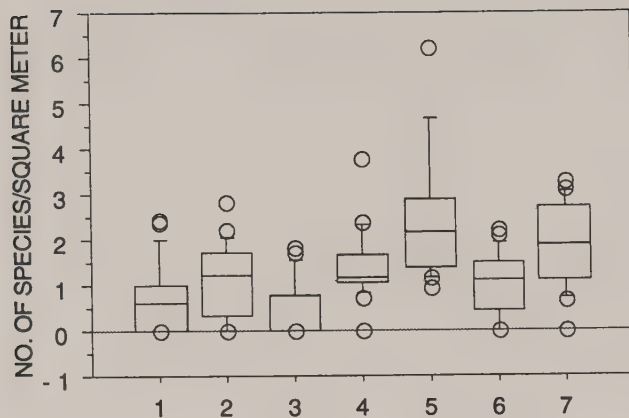


Figure 9a. Box plot of the number of species per square meter for 1996.

Figure 9b. Box plot of the number of species per square meter for 1997.

Figure 9c. Box plot of *Awaous guamensis* for 1996.

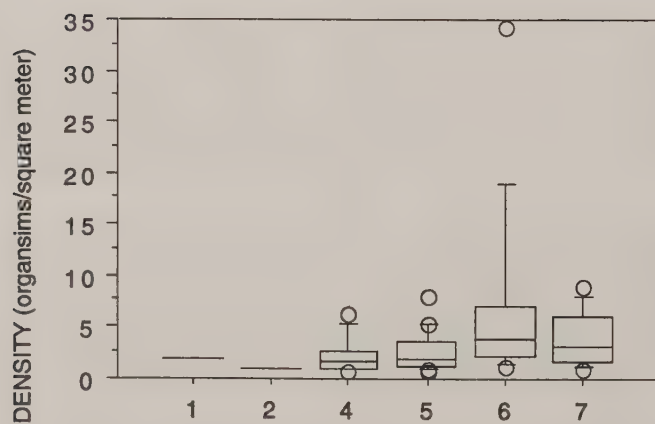
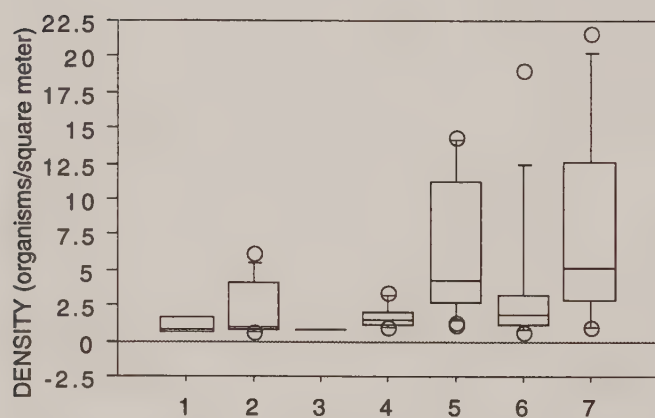
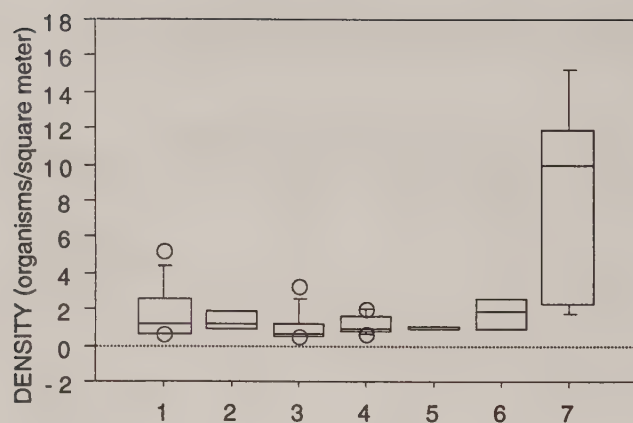


Figure 9d. Box plot of *Awaous guamensis* for 1997.

Figure 9e. Box plot of *Stiphodon elegans* for 1996.

Figure 9f. Box plot of *Stiphodon elegans* for 1997.

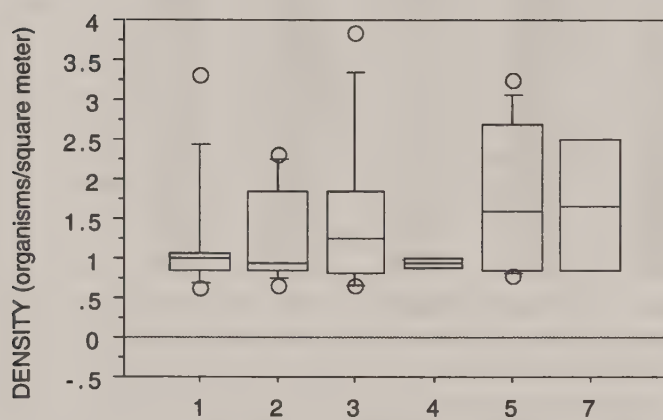
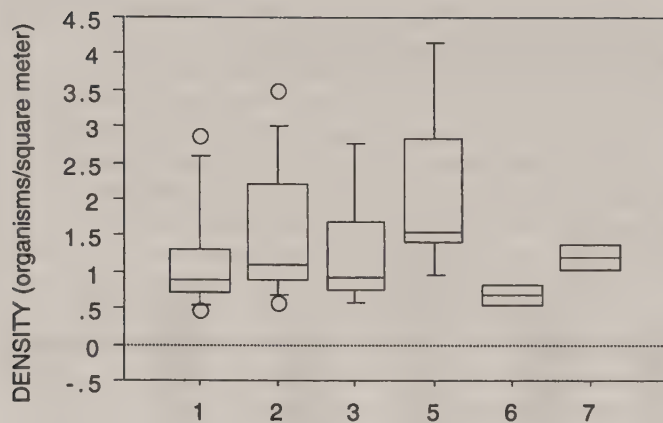
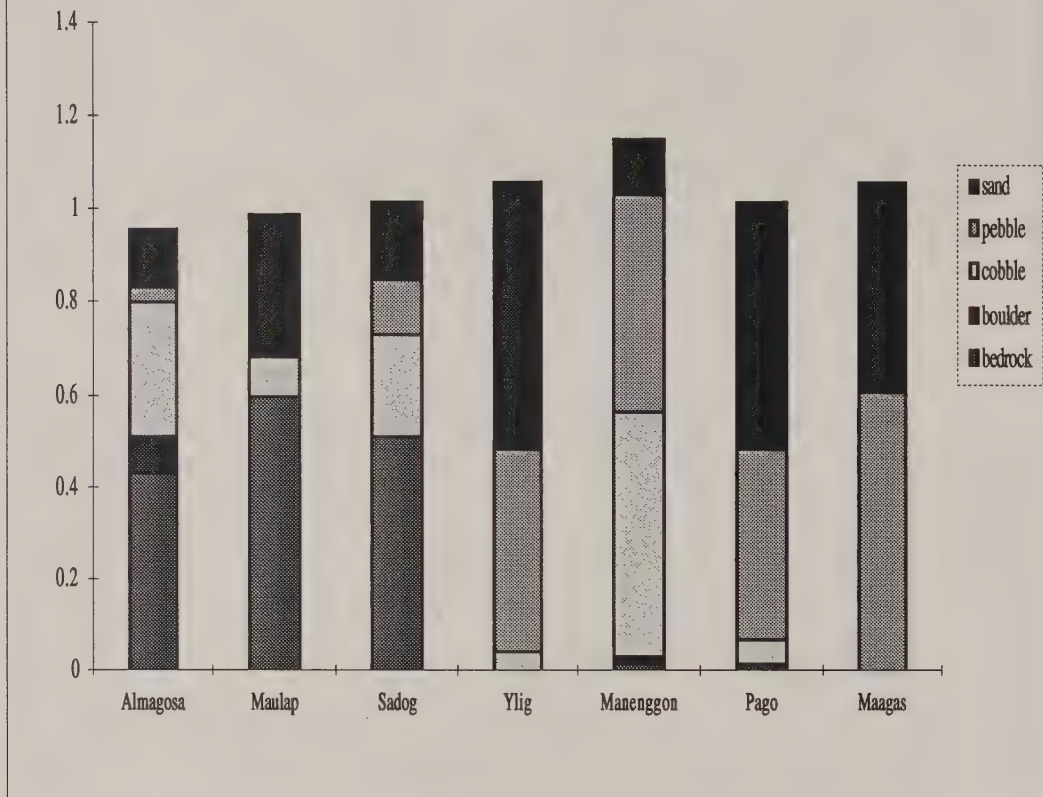


Figure 9g. Box plot of *Macrobrachium lar* for 1996.

Figure 9h. Box plot of *Macrobrachium lar* for 1997.

Table 2. Percent substrate of total area sampled (Y-axis) per stream (X-axis) in 1997.



Velocity readings did not indicate any substantial patterns in terms of where fish were found. In areas where faster moving waters were predominant, *S. elegans* were seen often. However, *Awaous guamensis* were seen in slower, deeper waters. A total of 41 days were spent in the field and approximately 75% of these days were devoted to the initial study and the Fena project and the remaining 25% were devoted to identifying species residing in other rivers not associated with the initial study and Fena. A log of species identified in all rivers visited during FY97 has been started and is available upon request.

In addition to the general data needs and analysis associated with this project several individuals have visited or called the office requesting assistance in freshwater species identification. A crude version of a freshwater field guide was compiled during FY97 to address these requests and to provide some continuity for future staff, who worked on this project. This guide is available upon request.

For historical documentation purposes the US Navy (COMNAVMARIANAS) agreed to open Fena Reservoir to the public for fishing on weekends. They presently allow 50 people in a day and this requires pre-registration and a \$5.00 fee. Data is taken at the end of each fishing day however, the data may not be qualitative enough to allow catch assessments to be made. Fish stocks and fish populations need to be tracked in order to determine the effects of fishing on this resource.

DISCUSSION

Although, the Modified Point Quadrat (Baker and Foster, 1992) survey method has been used in Hawaii and elsewhere, this study raised some concern regarding small or variable quadrat size. With smaller quadrat sizes or less common organisms patterns appear in the data that are related to quadrat size. However, the use of more uniform quadrat sizes did not eliminate the problem for some species. Larger quadrat sizes would probably help, but there are practical limits to the size of quadrats that can be used in visual surveys. Also because the streams in many Pacific islands are small, variable quadrat size may be limited by the stream width. This method is useful for detecting broad patterns of distribution, but for many confirmatory statistical tests, other designs may work better. Three species of nerite gastropods and one species of fish were not found above the reservoir. The dam probably excludes the flagtail, *K. rupestris*, because it is not morphologically adapted for climbing. It is also absent above natural waterfalls in most streams of Guam.

In addition to the four species that occurred throughout all streams surveyed, there were species such as the gobies, *M. cavifrons* and *S. leprurus*, which were present only in some of the streams. *M. cavifrons*, which typically resides in the estuarine portion of streams, was recorded in the Maulap, Almagosa, and Sadog streams above the reservoir and within the reservoir. The occurrence of this species only in the streams above the reservoir was surprising and cannot be explained. *S. leprurus* is typically found in the upper portions of streams and the portion of Manenggon River sampled was typical habitat for this species (personal observation). *S. leprurus* has usually been seen in the upper reaches of streams where faster flowing water is present and where substrate is typically bedrock. The distribution of these species were not likely to have resulted from the effects of the reservoir.

It appeared that the reservoir may have affected the densities of some species, but not necessarily in ways that were predicted. The mean densities of *S. elegans* were higher in the control streams. One factor that could affect the density of macrofauna present in the streams above the reservoir is predatory fish in the reservoir. The reservoir was stocked with the peacock bass, *Cichla ocellaris*. This is a sport fish that could prey upon migrating larvae, juveniles or adult *S. elegans*. However, the control streams have flagtails, *K. rupestris*, which are also predators (Allen, 1991), but seem to feed primarily on invertebrates. The absence of flagtails above the reservoir may also explain why the densities of *M. lar* were higher in the experimental streams than in the control streams.

The differences in the proportions of substrate types sampled probably contributed to the high variability of densities between streams. Other studies have shown that *A. guamensis* and *S. elegans* are found more often on one substrate type than others (Parham, 1996 and Kinzie, 1988). Substrate type also determines food availability (Kinzie, 1988) and in turn is more than likely the driving force behind where each species is found.

This study shows that dams and reservoirs in tropical streams may not have severe effects on most species. However, these ecosystems are complex and there is high variability between streams.

A total of 41 days were spent in the field. Approximately 75% of these days were devoted to the initial study and the Fena project, and the remaining 25% were devoted to identifying species residing in other rivers not associated with the initial study and Fena. A log of species identified in all rivers visited during FY97 has been started and is available upon request.

RECOMMENDATIONS

This is the second phase in developing a long-term freshwater monitoring and management program. The next phase should include assessing Fena Reservoir's fish stock as a short-term project. It is important to assess how the fish stocks within Fena could affect the indigenous macrofauna in the long run. This project should move towards assessing the quality of Guam's freshwater resource, which entails determining the rate of erosion and sediment loading in our streams thus how much actually reaches the coral reefs. This would integrate existing island-wide water monitoring and coral reef protection.

PROJECT COST

The estimated cost of the program is \$361,100.

This report was prepared by: Georgette Bello Concepcion

LITERATURE CITED

- Allen, Gerald. 1991. Freshwater fishes of New Guinea. 268 pp.
- Baker, John A. and Susan A. Foster. 1992. Estimating density and abundance of endemic fishes in Hawaiian streams. State of Hawaii, Department of Land and Natural Resources, Division of Aquatic Resources. 50 pp.
- Best, Bruce R. and Carolyn E. Davidson. 1981. Inventory and atlas of the inland aquatic ecosystems of the Marianas Archipelago. University of Guam Marine Laboratory, Technical Report 75. 225 pp.
- Hankin, D.G. and G.H. Reeves. 1988. Estimating total fish abundance and total habitat area in small streams based on visual estimation methods. Canadian Journal of Fisheries and Aquatic Science 45: 834-44.
- Kennedy Engineers. 1974. Fena watershed and reservoir management study and plan. Pacific Division, Naval Facilities Engineering Command. 138 pp.
- Kinzie, Robert A. 1988. Habitat utilization by Hawaiian stream fishes with references.
- Maciolek, J.A. and J.I. Ford. 1987. Macrofauna and environment of the Nanpil-Kiepw River, Ponape, Eastern Caroline Islands. Bulletin of Marine Science 41: 623-632.
- McDowall, R.M. 1991. Diadromy: Origins and definitions of terminology. Copeia 1991: 248-251.
- Moyle, P.B. and D.M. Baltz. 1985. Microhabitat use by an assemblage of California stream fishes: developing criteria for instream determinations. Transactions of the American Fisheries Society 114: 695-704.
- Nelson, S.G. and L. Eldredge. 1991. Distribution and status of introduced cichlid fishes of the genera *Oreochromis* and *Tilapia* in the islands of the South Pacific and Micronesia. Asian Fisheries Science 4: 11-22.

- Nelson, S.G., B.D. Smith, J.E. Parham, B. Tibbats and F. Camacho. 1995. A survey of the streamfishes of the upper reaches of the Ngermeskang River, Palau, with recommendations for conservation and monitoring. University of Guam Marine Laboratory, Technical Report No. 100. 18 pp.
- Nishimoto, R.T. and D.G.K. Kuamoo. 1991. The occurrence and distribution of the native goby (*Lentipes concolor*) in Hawaii Island streams with notes on distribution of other native fish species. In, New Directions in Research, Management, and Conservation of Hawaiian Freshwater Ecosystems; Proceedings of the 1990 Symposium on Freshwater Stream Biology and Fisheries Management. Department of Land and Natural Resources, State of Hawaii. pp. 238-271.
- Parham, James E. 1995. Habitat use by an assemblage of tropical island oceanic island streamfish. MS Thesis, University of Guam. 54 pp.
- Polhemus, Dan A., John A. Maciolek, and John Ford. 1992. An ecosystem classification of inland waters for the tropical Pacific islands. *Micronesica* 25: 155-173.
- Young, Fred J. 1988. Soil Survey of Guam. United States Department of Agriculture, Soil Conservation Service. 166 pp.

JOB PROGRESS REPORT COORDINATION PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: F-1R-5
SUB-PROJECT NO.: F-3
JOB NO.: 1

JOB TITLE: Technical Guidance to Projects Affecting Guam's Fish Resources (2710,2720)

PERIOD COVERED: October 1, 1995 to September 30, 1996

BACKGROUND

The Division of Aquatic & Wildlife Resources' (DAWR) professional Fisheries Staff devoted a significant percentage of their time and effort to technical assistance to fulfill the statutory responsibility to review and comment on development plans, rezoning applications, and various permit applications. Because of the size and complexity of some of these developments, the Fisheries Staff's review responsibility requires a continuing commitment that could extend even beyond project completion.

The Division's Technical Assistance Program (TAP) within the Administration/Coordination Section continues to handle the majority of the technical assistance. During the last quarter of the fiscal year, the lone TAP program employee resigned, shifting the workload to other Division staff. A local appropriation provides funding for a technical assistance staff, a Biologist II. He is primarily responsible for reviewing projects submitted to the Advisory Review Committee (ARC) for action by the Territorial Land Use Commission and for the review of clearing and grading permit applications. He also participates in the review of other permit applications and environmental documentation. The professional staff within the Fishery Section provide technical support to the TAP staff, and occasionally takes the lead in the review of projects involving their particular expertise, such as those that may have endangered species (sea turtles) impacts and those involving coral reefs.

OBJECTIVES

1. To minimize adverse environmental impact resulting from the construction of recreational, commercial, residential, industrial or public utility facilities.
2. Provide technical assistance to military and civil agencies relative to the management and protection of fish resources.

FINDINGS

Fisheries Staff have been actively involved in the technical guidance function during this segment. Numerous development plans, impact statements, and permit applications have been submitted to the Division for review. Field investigations and meetings with responsible agencies have been conducted in many cases as a part of the review process.

Various Fisheries Staff members actively serve as members of the following groups:

1. Recreational Water Use Master Plan
2. Western Pacific Regional Pelagic Plan Monitoring Team
3. Western Pacific Regional Bottomfish Plan Monitoring Team
4. Federal Data Coordinating Committee
5. The Coral Reef Initiative Technical Support

Members of the Fisheries Section attended 47 meetings and made 17 field inspections during FY97 pertaining to the protection of Guam's natural resources. Additionally, staff have continued to actively consult with various civil and military agencies on environmental matters. Division staff maintain close liaison with the Department of Land Management, Department of Parks and Recreation, Guam Bureau of Planning, Guam Environmental Protection Agency, University of Guam, U.S. Army Corps of Engineers (ACOE), U.S. Fish and Wildlife Service, Western Pacific Regional Fisheries Management Council, National Marine Fisheries Service, U.S. Navy, the U.S. Coast Guard, and U.S. Air Force regarding matters of environmental concern. In addition, staff members actively consulted with the numerous off-island visitors, representing various agencies and organizations, who visited during the segment.

Considerable public contact was maintained by Fisheries Staff during the reporting segment. In addition to occasional interviews on radio, television, and in the newspaper, they also gave talks to a number of civic groups, and schools.

Some specific Technical Assistance activities provided by the Fisheries Section included:

- 1) Technical staff continued to invest considerable time in monitoring and evaluating the environmental impacts associated with the Piti Underwater Observatory (PUO). This included extensive photographic review of corals transplanted and determinations of damage. Regular field inspections were made to ensure construction work was complying with permit requirements.
- 2) Technical support to the Divisions TAP staff who represents the Department and the Division on the ARC, which met biweekly to review applications for rezoning, variances, and various types of development.
- 3) Offered comments and provided information to the Western Pacific Regional Fisheries Management Council (WESPAC) and the Plan Monitoring Team (PMT) on projects for bottom and pelagic fisheries. Information was provided on market sampling, and stock assessment, and from recreational and near-water commercial vessels. Staff attended 5 off-island, Council related meeting.
- 4) Reviewed and commented on four proposed bills that would affect fisheries.
- 5) Investigated three suspected fish kills in island waters during the year.
- 6) Responded to 13 requests for information on laws and regulations pertaining to fish, endangered species, fishing and importation of fish.

- 7) Made 27 presentations on fish resources to other organizations or groups during the year.
- 8) Provided statistical data on fisheries issues to the Bureau of Planning and Department of Commerce on a quarterly basis.

RECOMMENDATIONS

This project needs to continue to support the TAP. The TAP responsibilities should be reassigned to Agricultural Development Services with technical support from DAWR. The issues typically addressed more specifically deal with their area of responsibility but will still require close coordination.

PROGRAM COST

The estimated cost of the Technical Assistance project under F-1R-5 is \$24,000.

Report prepared by: Gerald W. Davis

JOB PROGRESS REPORT DEVELOPMENT PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO: F-2-D
SEGMENT: 6

PROJECT TITLE: Marine Fish Habitat Improvement and Aggregating Devices (2331)

PERIOD COVERED: October 1, 1996 to September 30, 1997

OBJECTIVE

To enhance access to Guam's heavily-utilized near-shore pelagic fishing grounds through the continued development of a system of fish aggregating devices (FADs).

SUMMARY

FAD development activity under Project F-2-D-6 focuses primarily on identification and survey of potential new sites, as well as the initial deployment of FAD systems. The project also includes enhancement projects such as the production of FAD location maps for fishers and the improvement of current FAD designs to extend the average time on station of the FAD systems. Maintenance procedures, modifications, recoveries, redeployments, and material procurement are conducted under Project No. F-3-D: Maintenance and Redeployment of Fish Aggregating Devices and Shallow Water Moorings.

The number of proposed sites in the Guam FAD program increased from 12 to 16 in FY97 with the authorization of the "Old NOAA", "Ledge", "Agat" and "Facpi 2" sites by the Army Corps of Engineers (Figure 1). Depth surveys for the "Old NOAA" and "Ledge" sites were conducted at the end of FY97. Deployment of a FADs at the newly authorized sites and depth surveys of the "Agat" and "Facpi 2" sites will be conducted in early FY98.

The recommendation to use the Indian Ocean "raft" as an economical, low-resistance and easily maintained alternative buoy system for windward FAD sites was tabled again in FY97 and will remain so until the Coast Guard grants DAWR an exemption from having to install navigation lights on this particular FAD buoy design. The basis for the exemption request is that the string of purse seine floats forming the raft poses little threat should a vessel collide into such a system. As depicted in Figure 2, the Indian Ocean raft system uses a flag to mark the location of the FAD. Present Coast Guard regulations requiring the installation of a navigation light would necessitate further modification of the raft to include another buoy on the terminal end of the buoy system to support a navigation light with 8 lantern batteries weighing nearly 20 pounds.

RECOMMENDATIONS

The project to develop and enhance the Guam FAD program under F-2-D-6 should be continued with the following recommendations for FY98:

1. Continue pursuit of program enhancement activities such as identification and permitting of potential new sites, and production of laminated FAD site maps and route planners for distribution to fishers.

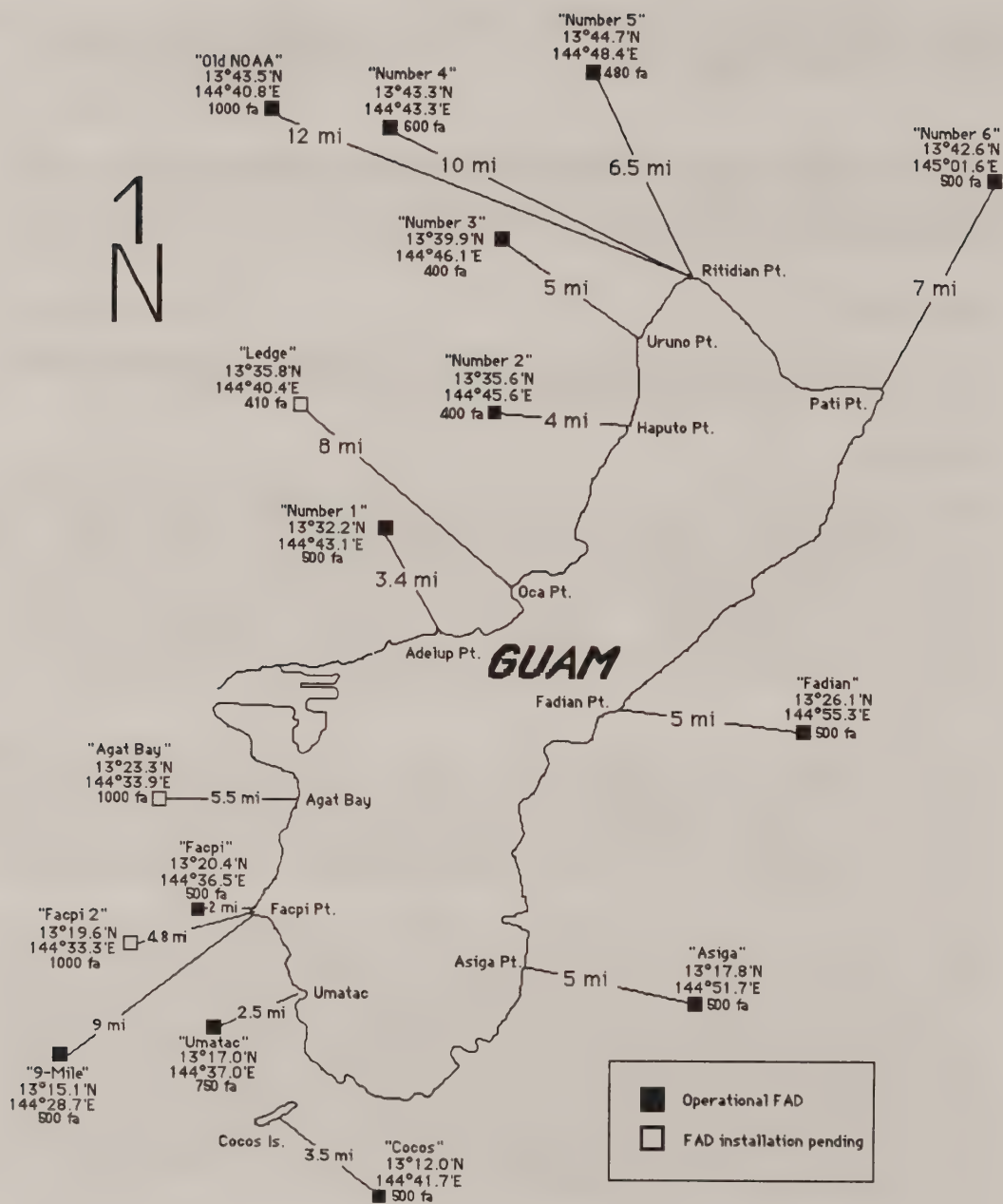


Figure 1. DAWR FAD Sites

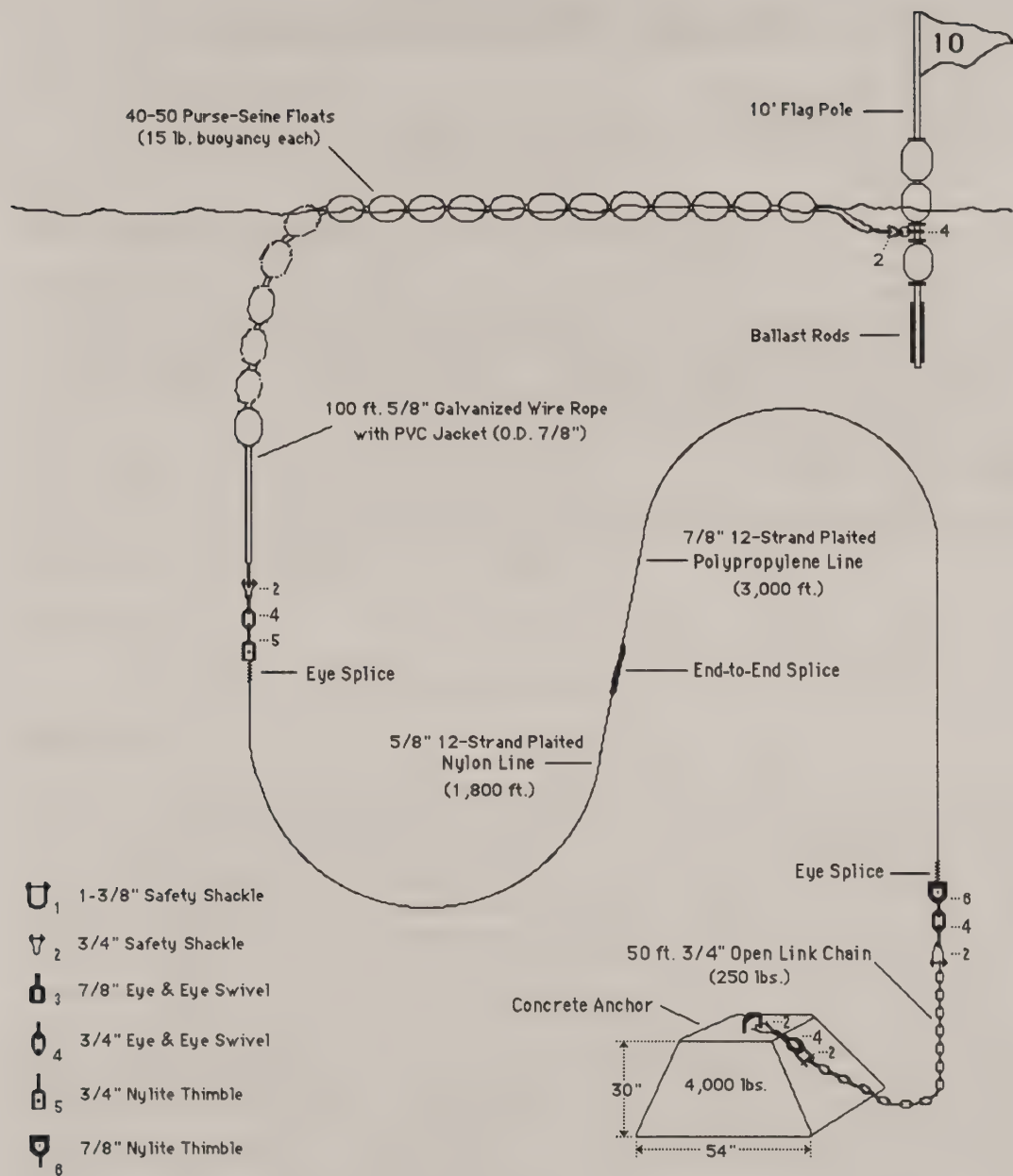


Figure 2. FAD with Indian Ocean Raft Buoy

2. Attach ribbons made of plastic strapping material to upper mooring chain of each FAD to further enhance bait and fish-holding characteristics of the FADs.
3. Obtain exemption from Coast Guard of navigation light requirement for Indian Ocean raft buoy and then begin experimental use of this design at several sites.
4. All four FADs recovered in FY97, as well as most other buoys recovered in previous years, broke off at a depth of between 250 and 575 feet. Considering that these breaks did not occur in either the upper- or lower-mooring hardware, or at any of the splices, the likely causes for failure can be narrowed down to either fish-bite or hook and line damage. Plans should thus be made to devise some practical form of protection for the upper-mooring rope in the 100 to 750-foot depth range.

PROGRAM COST

The FY97 estimated cost for the FAD project is \$34,912.

This report was prepared by Andrew A. Torres:

JOB PROJECT REPORT DEVELOPMENT PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO: F-2-D
SEGMENT: 7

JOB TITLE: Merizo Pier and Boat Ramp Facility

PERIOD COVERED: October 1, 1996 to September 30, 1997

SUMMARY

The Merizo pier and boat launching ramp facility is used extensively by the public. Extensive damage from vandalism, exposure to the elements, and heavy use make it necessary to renovate the parking facility, replace the damaged boat launching ramp with a larger ramp, and repair the pier's rubber bumpers, lighting, and electrical system. A project proposal to renovate and repair these facilities was submitted to the Department of Administration in FY95, then submitted to the Department of Public Works in FY96. During FY97, final engineering plans and specifications were approved by the Department of Public Works and a contract for the project was awarded. The project is being administered by the Department of Public Works.

OBJECTIVE

To renovate the existing public boat launching ramp facility and pier located in Merizo.

RESULTS

During FY97, final engineering plans and specifications for the renovation of the Merizo boat launching ramp facility and the repair of the Merizo pier were completed and approved by the Department of Public Works. The contract for the project, Project No. 350-5-1019-L-MER entitled "Upgrading of the Merizo Boat Launching Ramp Facility (Design-Build) and Repair of Merizo Pier," was awarded to Rex International, Inc. for \$678,200. The contract time for the completion of the entire project is 180 calendar days pending approval of local and federal permits. A groundbreaking ceremony for the project was held on September 5, 1997 at the Merizo pier. During the last part of FY97, two additional work items on the Merizo Pier were identified. These work items will be submitted to be part of Project 350-5-1019-L-MER. These are placing a vehicle barrier at the entrance of the pier and replacing the existing ladders. A vehicle barrier is necessary to prevent vehicles from driving onto the pier. Vehicles, including large commercial trucks, have been observed to drive onto the pier. The ladders on the pier have corroded and have sustained damage from large boats tying up to them. Replacing them with ladders constructed of galvanized pipe, similar to those at the Agat Marina, should increase their longevity. The ladders were repaired for corrosion and damage during FY95.

RECOMMENDATIONS

It is recommended that the scope of work for the additional work items on the Merizo pier be completed and submitted to be part of Project No. 350-5-1019-L-MER.

PROJECT COST

The cost of the project this fiscal year is \$4,755.

This report was prepared by: Thomas Flores, Jr.

JOB PROGRESS REPORT DEVELOPMENT PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: F-2-D
SEGMENT: 2

JOB TITLE: Development of Inshore Fishing Access Facilities (2331)

PERIOD COVERED: October 1, 1996 to September 30, 1997

SUMMARY

During FY97, information was sought to prepare for meetings with the various Municipal Planning Councils. Because of the complicated nature of finding information regarding land ownership and the public not fully understanding the fishing platform concept, it was decided to get the support for the idea by building two fishing platforms adjacent to the Togcha Cut in Talofoto village. The mayor and the Department of Land Management will be contacted. With the approval of the municipal planning council and the village public hearing, two fishing platforms will be put out to bid and constructed during the fiscal year.

BACKGROUND

The historical and traditional use along with design, site selection, environmental review and status of application to the Territorial Seashore Protection Commission has been discussed in previous fiscal year reports (Kruckenberg, 1989-1996).

OBJECTIVE

Plan, design and construct inshore fishing access facilities (reef flat platforms and cliff platforms) in the coastal areas of Guam

PROCEDURE

After a public hearing was held during FY96, it was decided to have one in each village after land ownership issues were clarified. A draft memorandum was written for the Department of Land Management to clarify land ownership near each area where fishing platforms will be placed.

RESULTS AND DISCUSSION

After the draft memorandum was written to the Department of Land Management, it was decided that we needed to get more information by contacting other offices and agencies within the Government of Guam to clarify the land ownership near the fishing platform sites. After the proper information has been gathered, the various mayors and Municipal Planning Councils will be contacted and additional public hearings may be held.

RECOMMENDATIONS

The Division still feels the fishing platform program will improve safety and fishing opportunities. During FY98, the Talofoto Municipal Planning Council will be contacted.

With their support, a public hearing will be held to construct two fishing platforms in the village and will be constructed during the fiscal year. We recommend that this same approach be used for all villages to receive fishing platforms.

PROGRAM COSTS

The estimated cost of the project was approximately \$12,451.47.

Report prepared by: Wayne Kruckenberg

JOB PROGRESS REPORT DEVELOPMENT PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: F-2-D
SEGMENT: 10

JOB TITLE: Masso Reservoir Restoration (2322)

PERIOD COVERED: October 1, 1996 to September 30, 1997

SUMMARY

The Masso Reservoir Project was reactivated in FY97. Duenas & Associates was selected to complete the engineering design, environmental assessment and permitting for the project. The Department will negotiate the contract fees with them and grant the Notice to Proceed. The project should be ready for construction bid during FY 1998 provided there are no permit problems.

BACKGROUND

The project will enhance sportfishing opportunities and/or protect the freshwater finfish resources at Masso Reservoir. The history and status of the Masso Reservoir Project was outlined in previous job progress reports (Kruckenberg, 1993 - 1996). The project involves dredging of the reservoir, rehabilitation of the water control gate structure, development of the area for public access and the shoreline for fishing. In addition, sediment basins will be constructed in the Masso Valley watersheds.

OBJECTIVES

1. To provide an easily accessible freshwater fishing facility at Masso Reservoir.

RESULTS

Duenas & Associates was selected through a bid process to complete the engineering design, environmental assessment and permitting for the project. They have submitted a fee proposal for review. When the evaluation process has been completed and contract approved, the Notice to Proceed will be issued. After the work has been completed, the project will be placed out to bid for construction.

RECOMMENDATIONS

This program has valuable freshwater fishing potential for Guam while providing a safety factor and enhancing fishing opportunities. It is recommended that this job continue to develop a freshwater reservoir on Guam for sport fishing.

PROGRAM COSTS

The estimated cost of the project to date is approximately \$1,000.00.

Report prepared by: Wayne Kruckenberg

JOB PROGRESS REPORT DEVELOPMENT PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO: F-2-D
SEGMENT: 11

PROJECT TITLE: Fabrication and Deployment of Shallow Water Moorings (2331)

PERIOD COVERED: October 1, 1996 to September 30, 1997

OBJECTIVE

To develop a shallow water mooring program at popular fishing and recreational diving locations to minimize anchor damage to reef habitats.

SUMMARY

Eight sites were added to the list of proposed DAWR shallow water mooring sites (SWMs), bringing the total number in the project to forty. Figure 1 provides an updated list of the SWM sites and maps their approximate locations; Figures 2 - 10 provide a more detailed illustration of each site. Some sites may be deleted from the list at a later time if they are found to be in areas no longer suitable for fishing or diving, or are determined to be in conflict with local, federal, or military regulations or program objectives.

Figure 11 illustrates the design of the SWM systems to be used and their components. The smaller, more economical Type I buoy design will be used for sites outside of Apra Harbor because of its ability to withstand rough seas and typhoon conditions. The Type II buoy design on the other hand, places much more strain on the mooring system in rough conditions and thus may be reserved for use in Apra Harbor only. The type of anchoring system used for either type of buoy will be determined by the type of substrate at the selected anchor site: a cemented eye bolt for uneven rocky substrate, or a "Manta Ray" anchor for flat sandy sites.

Because the U.S. Coast Guard initially objected to the sites being located in areas frequently transited by small vessels and indicated that DAWR would thus be required to equip each SWM buoy with a navigation light, the majority of the proposed anchor sites were relocated closer to shore and at depths less than ten fathoms (60 feet). The relocation of the proposed sites into shallower water was found to be acceptable by the Coast Guard and obviated the need to install navigation lights on the buoys.

Although, the relocation of the buoys into shallower waters served to clear Coast Guard objections, the modification also necessitated authorization by the Guam Seashore Protection Commission (GSPC) since the sites were now to be placed into waters less than 60 feet. The application and review process, which is presently underway, will include several public hearings and may take six months to a year to complete.

Another potential delay to implementation of the project is a result of the fact that nineteen of the forty proposed SWM sites are located in waters controlled by the Navy. Official response regarding DAWR's request to install SWMs in Navy-controlled waters is still pending. Unfortunately, initial indications are that the Navy will not authorize any of the sites primarily due to safety and security concerns. Liability concerns were also raised,

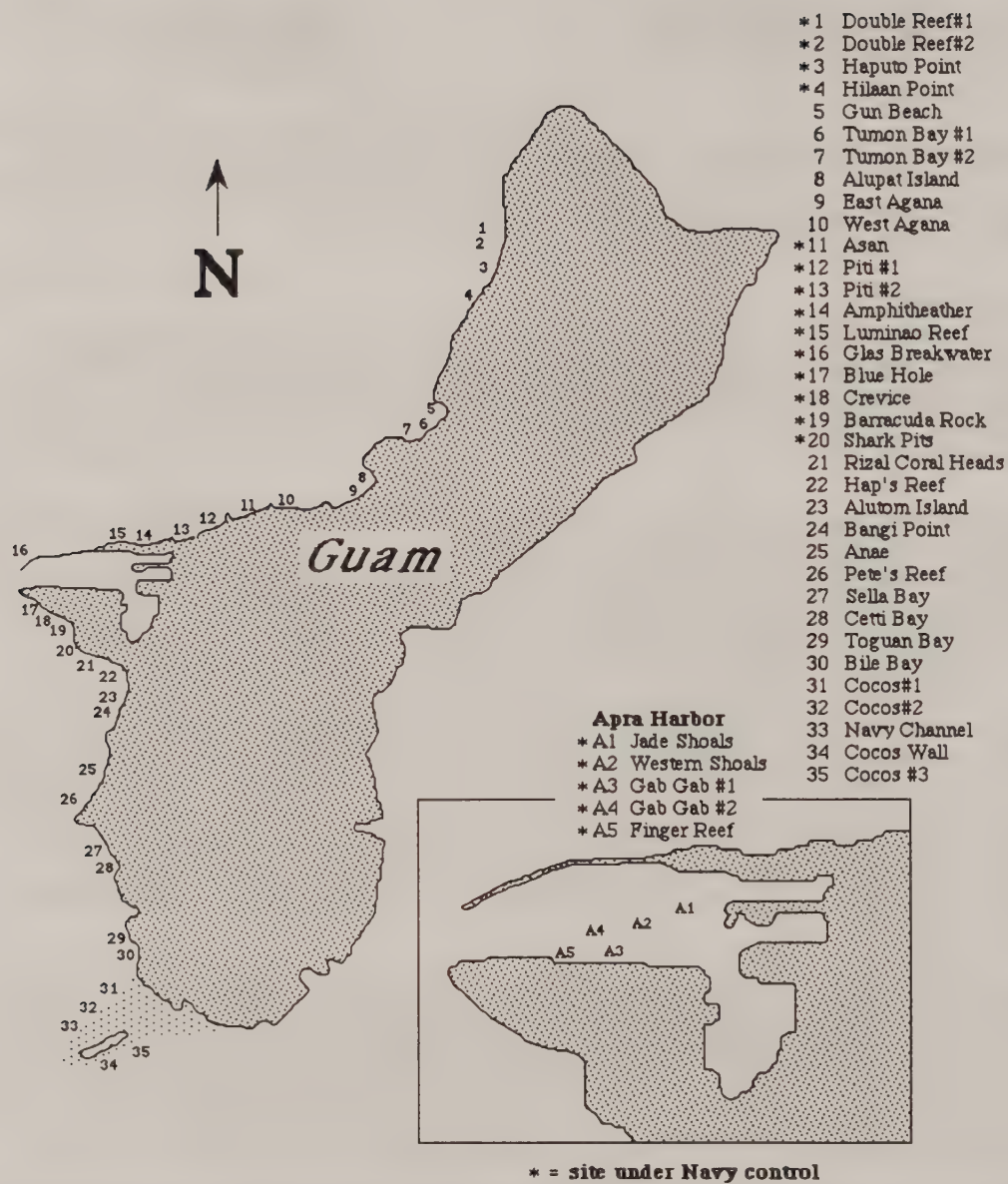


Figure 1. Shallow Water Mooring Sites

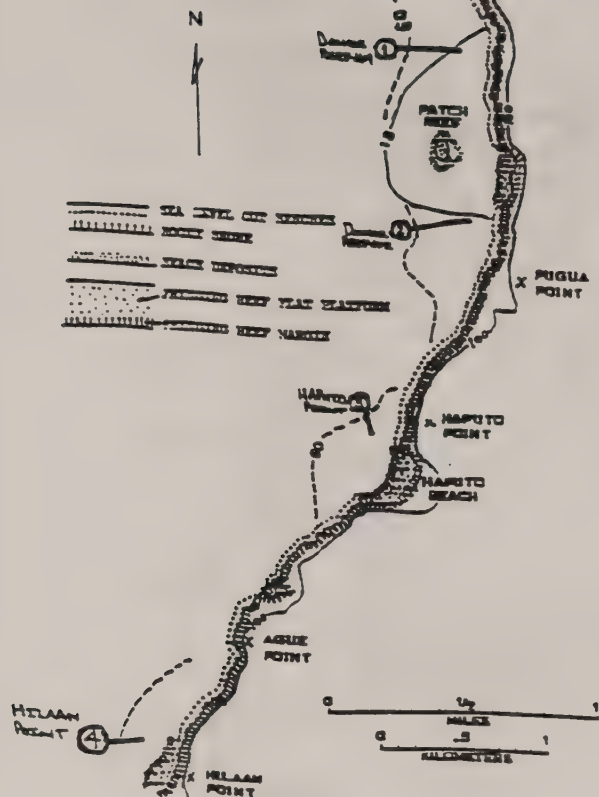


Figure 2. Sites 1-4. Map showing the 100 ft. coastal contour (solid line), rocky shorelines, beach deposits, cut benches, fringing reef-flat platforms (stippled region seaward of shoreline), reef margin, and the 18 ft. (solid line) and 60 ft. (dashed line) submarine contour lines.



Figure 3. Sites 4-5. Map showing the 100 ft. coastal contour (solid line), rocky shorelines, beach deposits, cut benches, fringing reef-flat platforms (stippled region seaward of shoreline), reef margin, and the 18 ft. (solid line) and 60 ft. (dashed line) submarine contour lines.

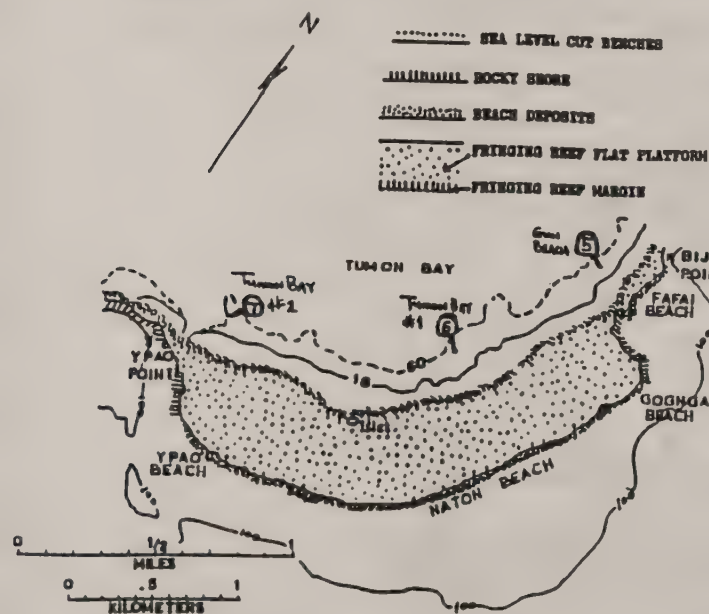


Figure 4. Sites 5-7. Map showing the 100 ft. coastal contour (solid line), rocky shorelines, beach deposits, cut benches, fringing reef-flat platforms (stippled region seaward of shoreline), reef margin, and the 18 ft. (solid line) and 60 ft. (dashed line) submarine contour lines.

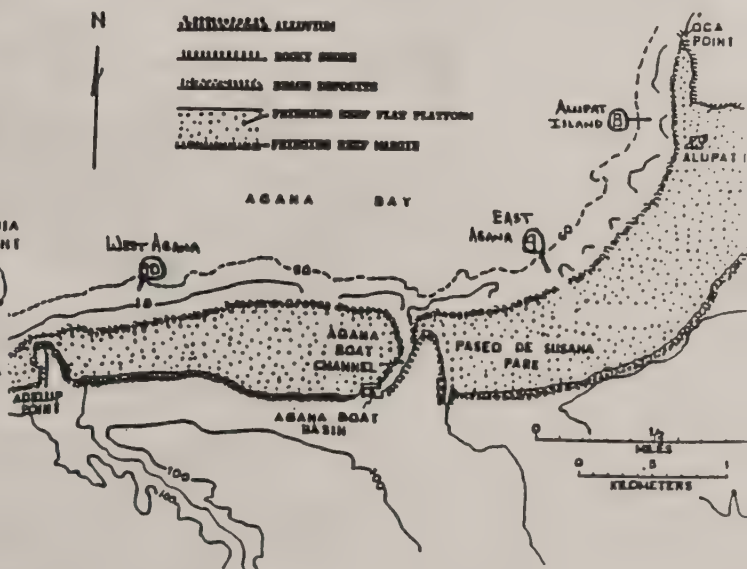


Figure 5. Sites 8-10. Map showing the 100 ft. coastal contour (solid line), rocky shorelines, beach deposits, cut benches, fringing reef-flat platforms (stippled region seaward of shoreline), reef margin, and the 18 ft. (solid line) and 60 ft. (dashed line) submarine contour lines.

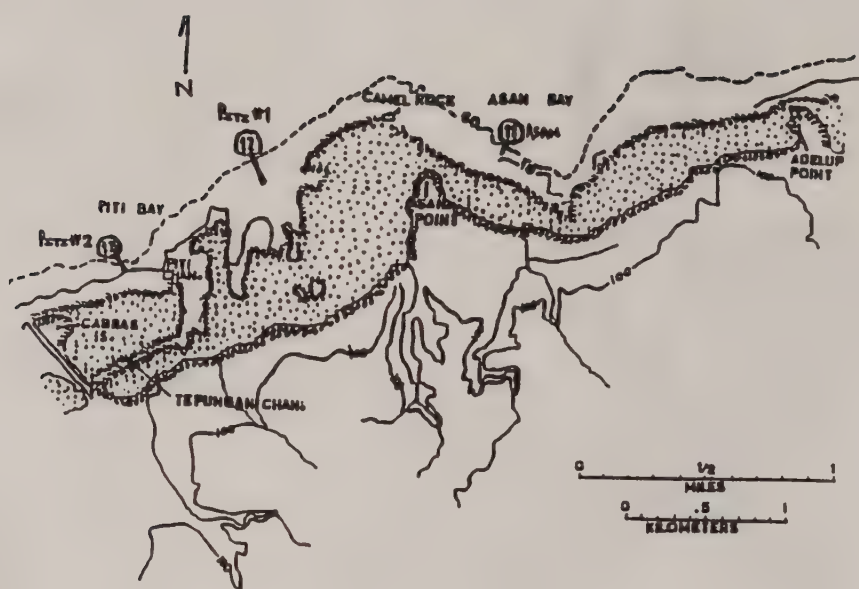


Figure 6. Sites 11-13. Map showing the 100 ft. coastal contour (solid line), rocky shorelines, beach deposits, cut benches, fringing reef-flat platforms (stippled region seaward of shoreline), reef margin, and the 18 ft. (solid line) and 60 ft. (dashed line) submarine contour lines.

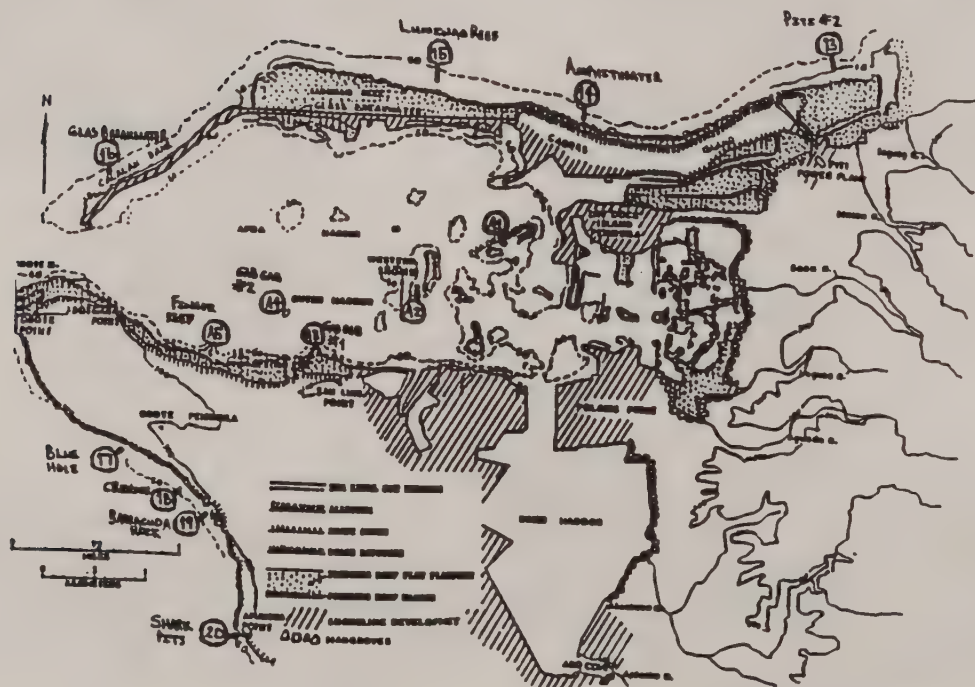


Figure 7. Sites 13-20 and A1-A5. Map showing the 100 ft. coastal contour (solid line), rocky shorelines, beach deposits, cut benches, fringing reef-flat platforms (stippled region seaward of shoreline), reef margin, and the 18 ft. (solid line) and 60 ft. (dashed line) submarine contour lines.



Figure 8. Sites 21-26. Map showing the 100 ft. coastal contour (solid line), rocky shorelines, beach deposits, cut benches, fringing reef-flat platforms (stippled region seaward of shoreline), reef margin, and the 18 ft. (solid line) and 60 ft. (dashed line) submarine contour lines.

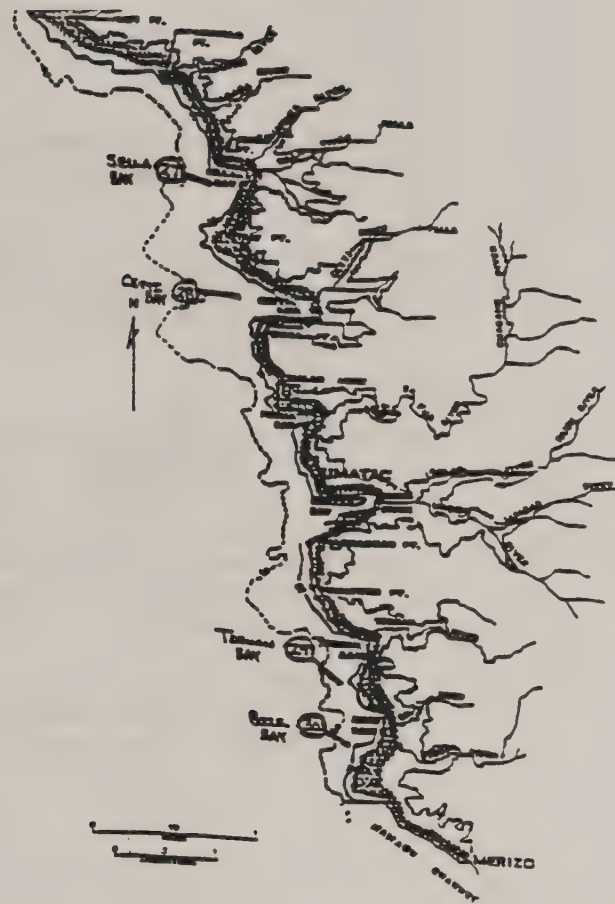


Figure 9. Sites 27-30. Map showing the 100 ft. coastal contour (solid line), rocky shorelines, beach deposits, cut benches, fringing reef-flat platforms (stippled region seaward of shoreline), reef margin, and the 18 ft. (solid line) and 60 ft. (dashed line) submarine contour lines.

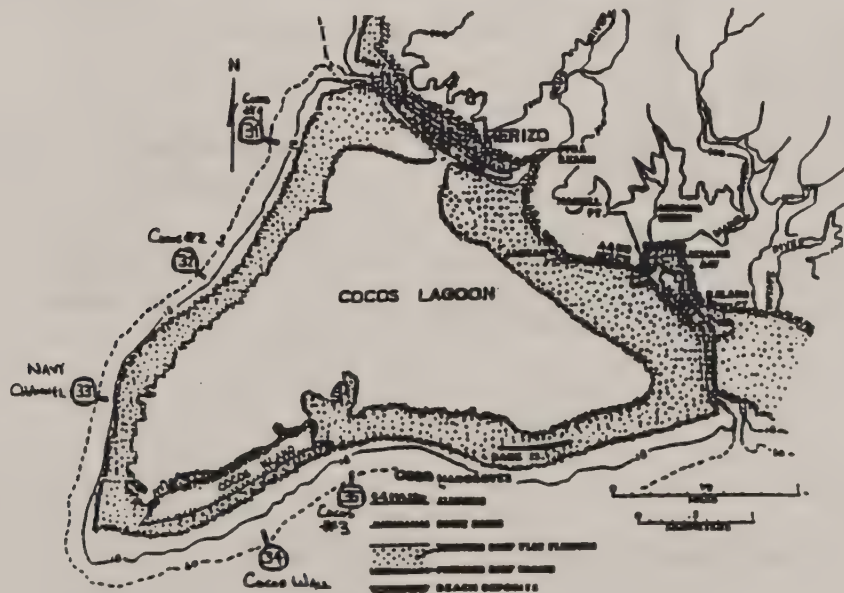


Figure 10. Sites 31-35. Map showing the 100 ft. coastal contour (solid line), rocky shorelines, beach deposits, cut benches, fringing reef-flat platforms (stippled region seaward of shoreline), reef margin, and the 18 ft. (solid line) and 60 ft. (dashed line) submarine contour lines.

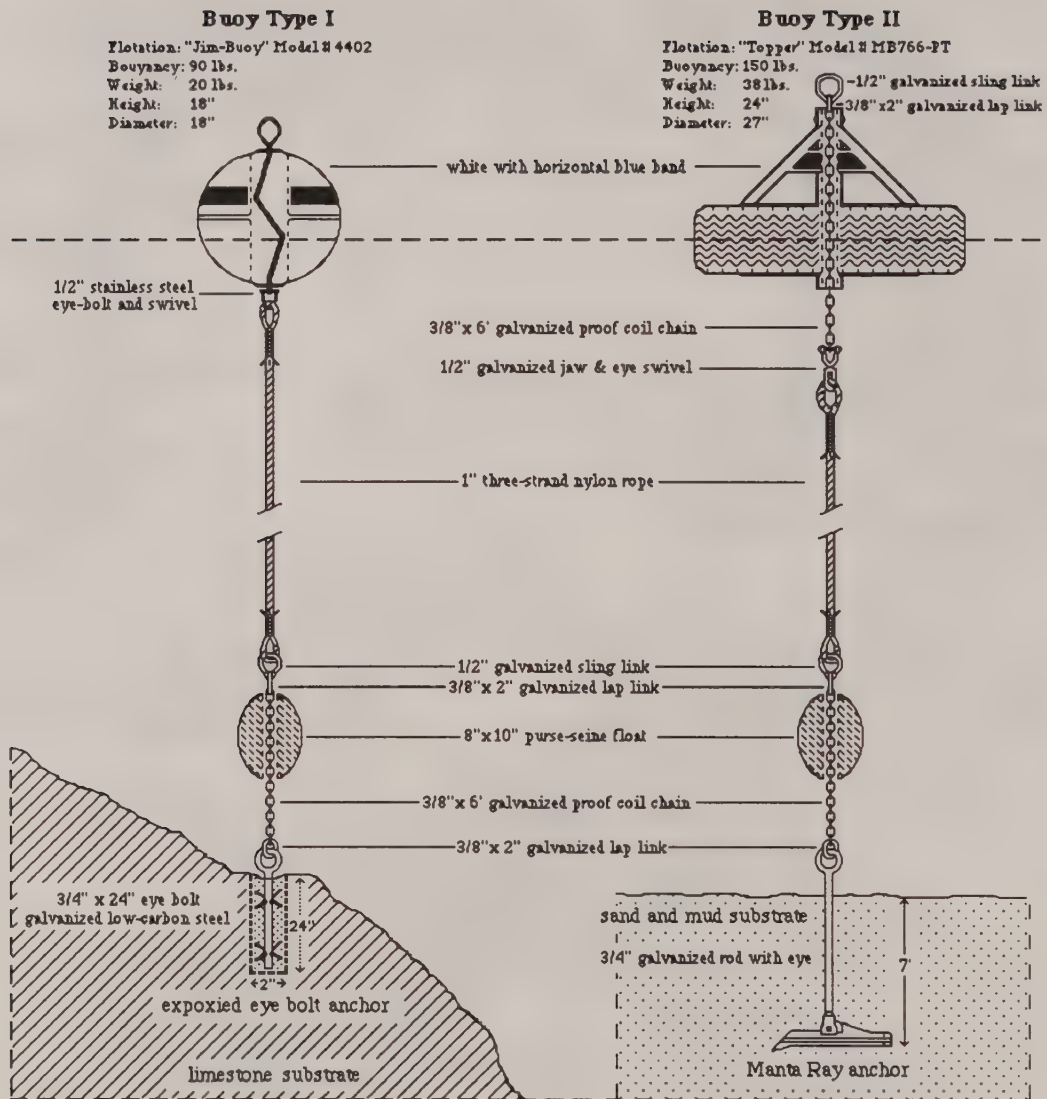


Figure 11. Shallow Water Mooring Designs

especially in light of the fact that Guam does not have a recreational-use statute that would protect the Navy from lawsuits that may arise as a result of the installation and use of the SWMs.

Purchase of ropes, chains and miscellaneous hardware to construct the SWMs and identification of a potential contractor to conduct actual installation procedures was completed in FY97.

RECOMMENDATIONS

The project to develop and enhance the Guam SWM program under F-2-D-11 should be continued with the following recommendation for FY98:

1. Continue with necessary steps to obtain Seashore Protection Commission authorization for all SWM anchor sites located in waters shallower than 60 feet. Authorization by June 1998 would allow for installation of the anchors during the dry-season calm-water period between July and September.
2. Pursue authorization of SWM sites located in Navy-controlled waters; particularly those sites that do not fall within a designated explosive arc. Such authorization is contingent upon enactment of a recreational use statute for Guam.

PROGRAM COST

The FY97 estimated cost for the SWM project is \$40,755.

This report was prepared by: Andrew A. Torres:

JOB PROGRESS REPORT DEVELOPMENT PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO: F-3-D
SEGMENT: 1

PROJECT TITLE: Maintenance and Redeployment of DAWR FADs and SWMs (2331)

PERIOD COVERED: October 1, 1996 to September 30, 1997

OBJECTIVES

1. To maintain, preserve and efficiently replace DAWR's fish aggregating devices.
2. To maintain, preserve and efficiently replace DAWR's shallow water moorings.

SUMMARY

FADs

Figure 1 lists the respective coordinates of the thirteen operational FADs and maps their approximate locations. Figure 2 diagrams the design and construction of the FAD system presently being used at each of the sites.

Five FADs came off station in FY97, the Number 4 site accounting for two of the losses. Three of the lost FADs were recovered shortly after they were reported missing. A fourth buoy was recovered by the Japanese Coast Guard on 8/29/97 approximately 840 miles north-northwest of Guam. This FAD is believed to be either the Umatac FAD lost in January, 1996, or the Number 4 FAD lost sometime around April, 1997. Neither of these FADs were deployed with a specific site decal affixed to the buoy.

Interestingly, all four recovered FADs broke off at a depth of between 250 and 575 feet. Considering that these breaks did not occur in either the upper- or lower-moorings hardware, or at any of the splices, the likely causes for failure are narrowed down to either fish-bite or hook and line damage. Plans are thus being made to provide some practical form of protection for the upper-moorings rope in the 100 to 750-foot depth range.

The average time on station for the FADs for FY97 was between 18 and 20 months; roughly a 5-month increase from the FY96 average of just over 13 months. The expansion of the FAD program from four to twelve sites between FY94 and FY95, and the fact that eight newly-deployed buoys were included in calculating the FY96 figure, best explains the previous year's shorter average time on station.

The average cost for the installation each 500-fathom FAD system in FY97 was \$7,802.41 (Table 1). A 1,000-fathom FAD system costs an extra \$1,770.00 due to the additional 3,000 feet of polypropylene rope necessary to complete the system. Table 2 provides a summary of recovery and buoy and light replacement activity requiring the use of an offshore vessel and the associated cost for services.

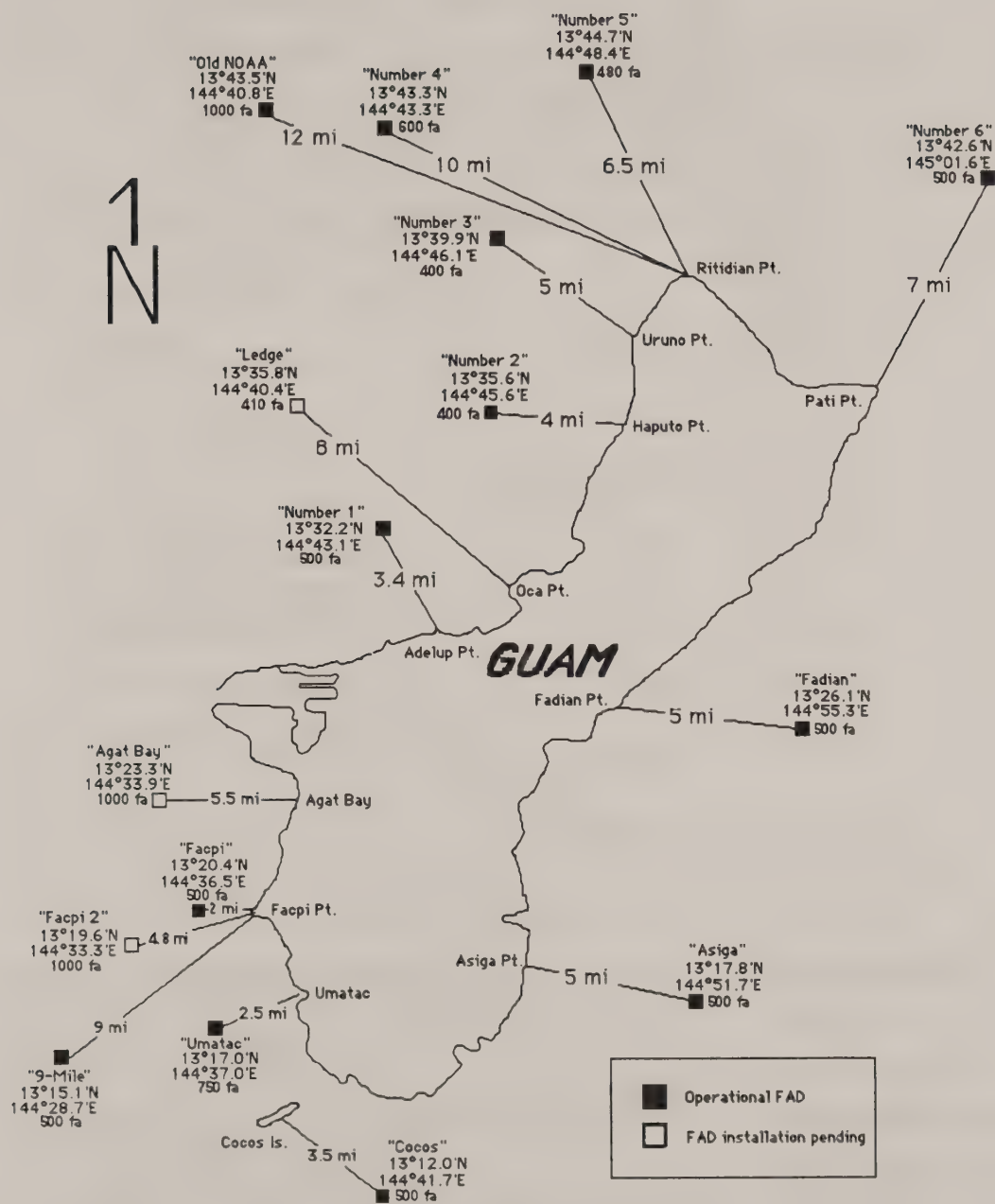


Figure 1. DAWR FAD Sites

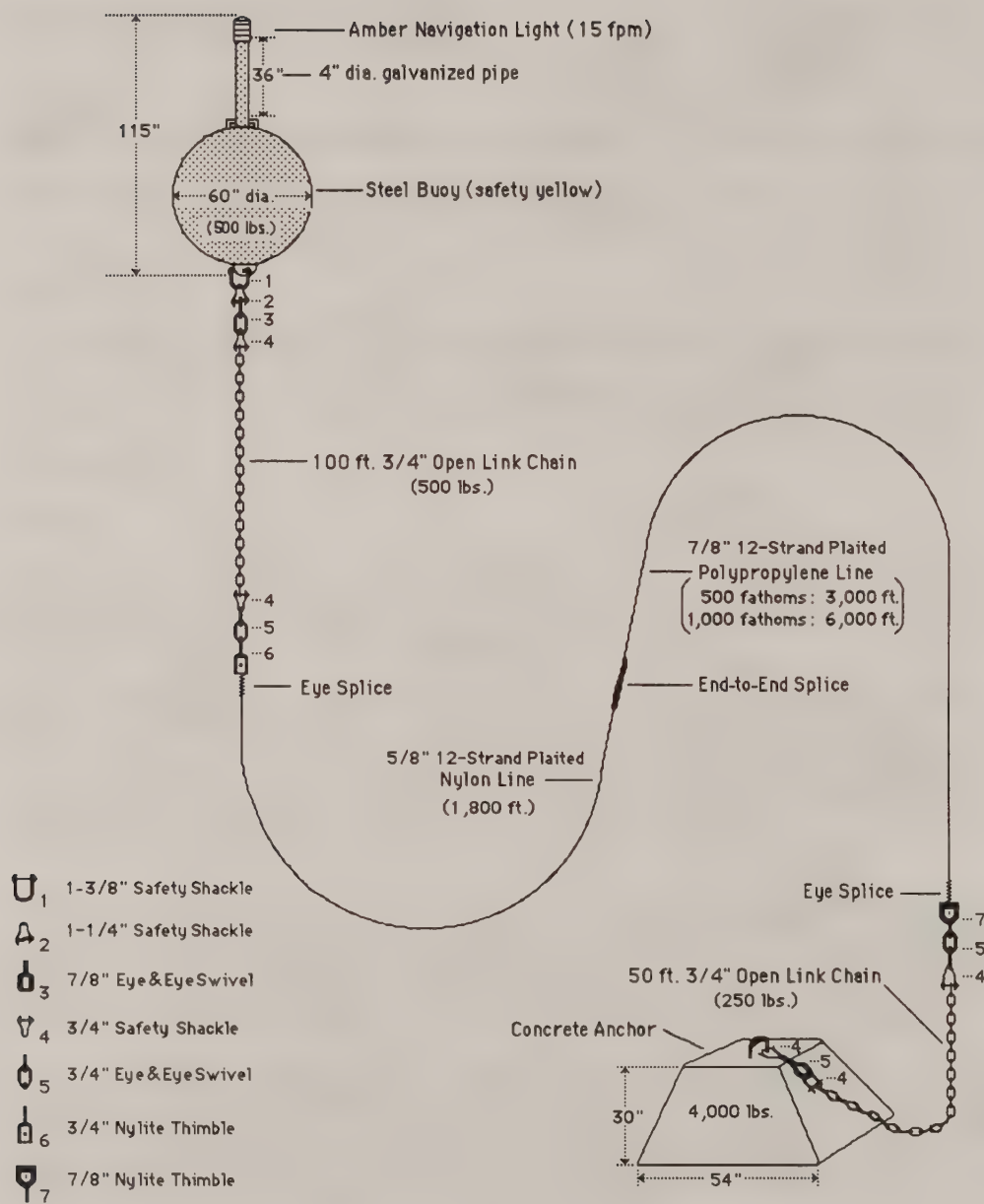


Figure 2. FAD with Spherical Steel Buoy

Table 1. FY97 Average Cost per 500-Fathom FAD System

<u>Item/Service</u>	<u>Cost</u>
Buoy	\$518.50
Buoy Preparation*	\$494.00
Anchor Block	\$368.96
Mooring System (500 fathoms)**	\$4,138.90
Navigation Light and Batteries	\$242.93
Loading and Deployment	\$2,039.12
Total:	\$7,802.41

* Includes sanding, painting, welding and moving services.

** Additional \$1,770.00 for 1000-fathom system

Table 2. FY97 Offshore Vessel Activity and Costs

<u>Activity</u>	<u>Date</u>	<u>Cost</u>
Recovery of Facpi FAD	11/28/96	\$852.00
Recovery of Fadian FAD	12/12/96	\$1,571.00
Replace lights: Nos. 1-4	03/17/97	\$1,290.00
Redeploy Facpi FAD; replace 9-mile and Umatac FAD lights	03/18/97	\$ 2,412.00
Redeploy No. 4 & No. 5 FADs; replace lights: Nos. 1-3	06/23/97	\$ 3,334.00
Recovery of No. 4 FAD	08/08/97	\$ 1,073.00
Redeploy Cocos and Fadian FADs; replace lights: Asiga, 9-mile, Umatac FADs	09/05/97	\$ 4,764.00
Redeploy No. 4 FAD; replace lights: Nos. 5-6	(scheduled)09/30/97	\$2,755.00

SHALLOW WATER MOORINGS (SWMS)

There was no maintenance or replacement activity recorded for the SWM project in FY97. Installation of SWMs is expected to begin sometime in mid-FY98.

RECOMMENDATIONS

The project to maintain and reinstall FADs and SWMs should be continued with the following recommendations for FY98:

1. Reestablish the open account to prepare FAD systems for deployment, conduct actual deployments, recover errant buoys, and perform on-site replacement of expired navigation lights and worn FAD buoys on an as-is-needed basis.
2. Identify and contract a private vendor to conduct SWM maintenance and reinstallation services on a short notice and as-is-needed basis similar to that of the FAD project.

3. Reorder buoys, concrete anchors, ropes, chains and other miscellaneous mooring hardware to establish an inventory sufficient to replace up to ten 500-fathom FAD systems and twenty 10-fathom SWM systems .
4. Repair the Division's existing work-boat to allow for some minor maintenance routines to be conducted until the arrival of the new work vessel.
5. Establish and maintain an inventory of other miscellaneous equipment, supplies and materials, such as navigation lights and batteries, necessary for both the FAD and SWM projects.

PROGRAM COST

The FY97 estimated cost for the project to continue maintenance and reinstallation of FADs and SWMs is \$85,941.

This report was prepared by Andrew A. Torres

GUAM COMMERCIAL FISHERIES

STATE: Territory of Guam

JOB TITLE: Commercial Fisheries on Guam

PERIOD COVERED: October 1, 1996 to September 30, 1997

SUMMARY

Commercial fisheries receipt books were given to fifteen vendors with seven being active during the fiscal year. The collected data was computerized and sent to NMFS in Hawaii.

BACKGROUND

The commercial fisheries program was established in 1979 to learn more about the fishery resource being caught and sold on Guam. The National Marine Fisheries Service (NMFS) initiated the program. In the beginning, data was only collected from the Guam Fishermen's Cooperative in Agana. The program has slowly grown over time with many of the early participants no longer in business. As part of the long-term program plan, data collection and management has shifted from NMFS in Hawaii to the Guam Division of Aquatic and Wildlife Resources (DAWR). Program responsibility has slowly increased to the point where DAWR now handles data collection, computer input and production of commercial landing tables. All data collected is forwarded to NMFS for further analysis by their staff for regional reports.

OBJECTIVES

To monitor, analyze and report locally caught fish sales and related activities through the collection of vendor receipts.

PROCEDURES

The Guam Commercial Fisheries receipt books are provided to each volunteer fish vendor. When the catch is purchased, each cooperating vendor is asked to record the following information: name of the person, date, hours fished, number of fishermen, fishing location and fishing method. The assigned fisherman number is placed on each receipt after it is returned. A record is kept of all new people who sell fish and when they have consistently sold fish are given a number. The catch information is broken down into six primary areas: (1) Bottom fish, (2) Reef fish, (3) Trawl (pelagic) fish, (4) Invertebrates, (5) Seaweed and (6) Imported Items. Each category of organisms has an assigned code number. Although there is a category for imported fish, the program is primarily intended to monitor locally caught and sold fish. There is space provided to indicate the number of items sold, total weight, price paid per pound, the value of the items, the total value of the transaction and any additional remarks. There are three copies of each receipt with one for the person selling the catch, the vendor and one for DAWR. Vendors are visited on a regular basis to monitor completion of the forms, collect completed receipt books, to check on errors and insure they have a supply of receipt books.

RESULTS

During FY97, vendor receipt books were collected from seven active cooperating vendors on a regular basis. In addition, eight inactive vendors were contacted who had been given receipt books but were not active in the program for a variety of reasons. The collected data was entered, cross-checked for accuracy and all questions about the data verified with the vendors. Data representing the actual sold catch from the program for the fiscal year has been transferred to the NMFS office in Hawaii for storage, inclusion in the "Fishery Statistics of the Western Pacific" and the bottom fish and pelagic plan monitoring team annual reports.

RECOMMENDATION

Develop regulations to require the person representing the catch to provide an identification number to each vendor when selling locally caught and imported fish. This would give a more comprehensive view of the commercial fishery activity around Guam.

Report prepared by: Wayne Kruckenberg

JOB PROGRESS REPORT RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: W-1R-5
SUB-PROJECT NO: W-1
STUDY NO.: 1
JOB NO.: 1

JOB TITLE: Determination of Current Population Size and Distribution of Guam Deer (1460)

PERIOD COVERED: October 1, 1996 to September 30, 1997

SUMMARY

Official logs with deer harvest statistics for Andersen Air Force Base (AAFB) were examined and revealed a total of 3,771 hunter sorties, a harvest of 115 deer, and a harvest rate of one deer per 16.3 hunter-days. On Naval Computer and Telecommunications Area Master Station (NCTAMS), there were 538 hunter sorties, a take of five deer, and a harvest rate of one deer per 46.3 hunter-days. Population trend data obtained with spotlight counts on AAFB showed no significant changes ($P > 0.05$) in deer numbers, with an average of 9.6 animals recorded per km during counts. On Naval Ordnance Annex (formerly Naval Magazine), spotlight counts revealed a significant decrease ($P < 0.001$) in deer numbers, with the average number of animals declining from 3.0 deer per km in FY96 to 1.9 deer per km in FY97. Revision of Guam's existing deer hunting regulations is an ongoing attempt to liberalize restrictions on the take of this species.

BACKGROUND

The Guam deer (*Cervus mariannus*), or Philippine deer, has been under investigation by the Division of Aquatic and Wildlife Resources (DAWR) since 1961 (DAWR 1961-1996). Preliminary information on distribution, population trends, and biology appeared in Wheeler (1979). Deer hunting statistics have been compiled annually since 1968. Guam has a split deer hunting season, running from October 1 to December 31 and from September 1-30. There is a bag limit of one antlered deer per season per license holder exclusive of any special harvest.

OBJECTIVES

To determine the current size and distribution of the deer population on Guam and to monitor population trends.

PROCEDURES

1. Conduct monthly spotlight counts on AAFB and Ordnance Annex, and periodic counts elsewhere on the island.
 - a. Record number, sex, age, and group composition.
 - b. Analyze count data and compare with previous data to discern population trends.
2. Monitor hunter participation and harvest during the legal hunting season.

3. Collect biological data from animals killed during the hunting season and from incidental sources such as road kills or confiscated animals.

RESULTS

Deer Hunting Statistics

Hunter questionnaires were discontinued in FY96 because of a lack of manpower and low return rates in previous years, which may have resulted in biased sampling of the hunter community. Proposed revised hunting regulations may remedy this problem by requiring hunters to complete the questionnaire prior to license purchase.

Records of hunting activity and harvest were kept by officials at AAFB and NCTAMS during the deer hunting season (Table 1). According to hunter logs from AAFB, 1,516.4 hunter-days (2,865 sorties; gun hunting only) were expended at Northwest Field (NWF) and resulted in the harvest of 108 deer. At Andersen South, 8.1 hunter-days (26 sorties; bow hunting only) were registered, with no deer taken. Andersen South was closed for hunting from September to December. Hunting areas on the main portion of the base (Munitions Storage Area [formerly the Conventional Weapons Storage Area], Tarague basin, landfill vicinity, and areas north and east of the flightline) recorded 346.4 hunter-days (880 sorties; primarily bow hunting), with 7 deer harvested. The Munitions Storage Area was only open for hunting in December and September. Hunter log books for NCTAMS were incomplete. From the available data, it was estimated that 231.6 hunter-days (538 sorties; gun and bow hunting) were expended, with five deer killed.

Table 1. Hunter effort and deer taken on AAFB and NCTAMS during FY97, based on official hunter logs.

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
Andersen Air Force Base													
<u>Northwest Field</u> (gun hunting only)													
No. hunter sorties	732	685	728									720	2865
No. hunter days (8 hr)	383.7	345.6	384.9									402.2	1516.4
Deer taken	25	19	33									31	108
Days effort/take	15.3	18.2	11.7									13	58.2
<u>Main Base</u> (primarily bow hunting; Munitions Storage Area was closed Oct and Nov)													
No. hunter sorties	126	195	224									335	880
No. hunter days (8 hr)	47	72	86.8									140.6	346.4
Deer taken	1	1	1									4	7
Days effort/take	47	72	86.8									35.2	241
<u>Andersen South</u> (bow hunting only; closed Oct-Dec)													
No. hunter sorties												26	26
No. hunter days (8 hr)												8.1	8.1
Deer taken												0	0
Days effort/take												-	-
NCTAMS (gun and bow hunting; closed Sep)													
No. hunter sorties	205*	136	197										538*
No. hunter days (8 hr)	85.9*	59.5	86.2										231.6*
Deer taken	1*	1	3										5*
Days effort/take	85.9*	59.5	28.7										174.1*

*data missing for first 10 days of September

Spotlight Count Trends

On AAFB, deer numbers observed on spotlight counts in FY97 revealed a non-significant increase (Mann Whitney *U*-Test, $U = 17.5$, $n_1 = 10$, $n_2 = 6$, $P > 0.05$) over from those of the previous year. The average number of deer seen per count increased from 58.7 (7.6 deer/km) in FY96 to 63.2 (9.6 deer/km) in FY97 (Table 2). Despite this, the largest single nightly count on AAFB decreased from 91 deer in FY96 to 73 deer in FY97.

Table 2. Composition of deer seen during spotlight counts on AAFB, FY97.

Class	----- 1996 -----			----- 1997 -----									Total	Mean	SD
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep			
Unclassed buck	1					0		2	0	2		1	6	1.0	0.9
Spike	4					3		3	2	2		1	15	2.5	1.0
2 pt	2					0		2	1	8		11	24	4.0	4.4
3 pt	2					1		1	4	2		2	12	2.0	1.1
4 pt	0					0		0	0	0		0	0	0	0
Doe	32					32		25	20	22		24	155	25.8	5.1
Yearling	3					2		6	7	7		9	34	5.7	2.7
Fawn	2					2		0	0	2		2	8	1.3	1.0
Unclassed deer	22					22		17	23	18		23	125	20.8	2.6
Total deer	68	nc	nc	nc	nc	62	nc	56	57	63	nc	73	379	63.2	6.5
Miles traveled	4					4		4	5	4		4	25	4.2	0.4
Km traveled	6.4					6.4		6.4	8	6.4		6.4	40	6.7	0.7
Deer/mi	17.0					15.5		14	11.4	15.8		18.3	92	15.3	2.4
Deer/km	10.6					9.7		8.8	7.1	9.8		11.4	57.4	9.6	1.5

nc = no count was made

On Ordnance Annex, deer numbers showed a significant decrease (Mann Whitney *U*-Test, $U = 0.5$, $n_1 = 9$, $n_2 = 5$, $P < 0.001$) in FY97 (Table 3) from FY96. The average number of deer recorded per count fell from 67.1 animals (3.0 deer/km) in FY96 to 44.8 animals (1.9 deer/km) in FY97 (Table 3). The largest single nightly count decreased from 88 deer in FY96 to 52 deer in FY97.

In November, DAWR staff assisted the US Fish and Wildlife Service (USFWS) with a large mammal survey of Ordnance Annex (Walker et al. 1996). Survey methodology replicated that used by Biosystems Analysis Inc. (1989) in a previous study. Transect results showed a four-fold increase ($P = 0.0001$) in deer sign from 1989 to 1996. Deer sign was much more common in forested habitats, especially degraded ravine forests, than in savanna. These data corroborate the results of DAWR spotlight counts on Ordnance Annex and indicate that deer numbers have increased dramatically on the base over the past decade (DAWR 1987-1996; this report).

Table 3. Composition of deer seen during spotlight counts on Ordnance Annex, FY97.

Class	----- 1996 -----			----- 1997 -----									Total	Mean	SD
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep			
Unclassed buck	1	1		3				7	1				13	2.6	2.6
Spike	0	2		3				2	1				8	1.6	1.1
2 pt	1	0		2				3	2				8	1.6	1.1
3 pt	2	0		1				2	2				7	1.4	0.9
4 pt	1	0		0				0	0				1	0.2	0.4
Doe	18	20		17				18	16				89	17.8	1.5
Yearling	3	4		7				4	2				20	4.0	1.9
Fawn	2	2		2				3	3				12	2.4	0.5
Unclassed deer	14	15		9				13	12				63	12.6	2.3
Total deer	45	44	nc	44	nc	nc	nc	52	39	nc	nc	nc	224	44.8	4.7
Miles traveled	15.3	15		14				14	14				72.3	14.5	0.6
Km traveled	24.6	24.2		22.5				22.5	22.5				116.3	23.3	1.1
Deer/mi	2.9	2.9		3.1				3.7	2.8				15.4	3.1	0.4
Deer/km	1.8	1.8		2.0				2.3	1.7				9.6	1.9	0.2

nc = no count was made

Other Activities

Work continued on the preparation of a new deer publication to update readers on recent population trends and hunter harvests, general biology, and ecological impacts, as well as needed management actions.

Steve Shea, a wildlife biologist with Tyndall Air Force Base in Florida, was contracted by the Air Force to evaluate the health of the deer herd on AAFB. Ten deer were collected on the base and necropsied during September. Blood, liver, kidney, heart and muscular tissue samples were collected. Live and field-dressed weights were taken and mandibles were extracted. The study's findings should be available in early 1998.

A revision to Guam's hunting regulations that will liberalize deer take was finalized in September and will be submitted to the Attorney General's office and the Twenty-Fourth Guam Legislature in FY98.

RECOMMENDATIONS

Continue monthly spotlight counts on AAFB and Ordnance Annex. Expansion of spotlight counts to Northwest Field and the Munitions Storage Area is recommended. Collect biological data from carcasses whenever possible. Written guidelines concerning hunter logbooks should be given to the proper personnel to ensure complete and accurate hunter participation records. A comprehensive investigation of the movements and habitat use of Guam's deer is needed. A study to examine the impacts of deer on native ecosystems remains a high priority.

PROGRAM COST

The estimated cost of the deer population and distribution project under W-1R-5 is \$32,000.

LITERATURE CITED

- Biosystems Analysis, Inc. 1989. Natural resources survey for the U.S. Naval Magazine, Guam (NavMag). Naval Facilities Engineering Command, Pearl Harbor, Hawaii.
- Division of Aquatic and Wildlife Resources. 1961-1996. Job Progress Reports - Federal Aid to Fish and Wildlife Restoration. Guam Dept. Agric., Mangilao.
- U.S. Fish and Wildlife Service. 1996. Faunal survey for the Ordnance Annex, Naval Activities, Guam. U.S. Fish and Wildlife Service, Honolulu, HI.
- Walker, R., G. J. Wiles, J. M. Morton, M. R. Lusk, and A. P. Marshall. 1996. Large mammal surveys on the Ordnance Annex. pp. 109-131 *in* U.S. Fish and Wildlife Service. Faunal survey for the Ordnance Annex, Naval Activities, Guam. U.S. Fish Wildl. Serv., Honolulu, Hawaii.
- Wheeler, M. E. 1979. The biology of the Guam deer. Div. Aquatic Wildl. Resources Tech. Rept. No. 3, Mangilao, Guam. 53 pp.

Report was prepared by: Dana T. Lujan and Gary J. Wiles

JOB PROGRESS REPORT RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: W-1R-5
SUB-PROJECT NO.: W-1
STUDY NO.: 2
JOB NO.: 1

JOB TITLE: Population Size and Distribution of Wild Pigs on Guam (1460)

PERIOD COVERED: October 1, 1996 to September 30, 1997

SUMMARY

Examination of hunter logs for Andersen Air Force Base (AAFB) revealed a total of 5,369 hunter sorties, a harvest of 412 pigs, and a harvest rate of one pig per 5.5 hunter-days. On Naval Computer and Telecommunications Area Master Station (NCTAMS), there were 1,070 hunter sorties, a take of 45 pigs, and a harvest rate of one pig per 10.3 hunter days. Harvest data were not available for other parts of Guam.

BACKGROUND

Wild pigs (*Sus scrofa*) are Guam's most important game species in terms of total numbers of animals harvested. This species has been studied by the Division of Aquatic and Wildlife Resources (DAWR) since 1967 (Conry 1988, DAWR 1967-1996). The island's wild pig population is descended from domestic *S. scrofa* introduced by the Spanish from the Philippines between 1672 and 1685. Wild pigs are found islandwide, but appear to be most numerous in the secondary limestone forests of the north and the ravine forests of southern Guam. Pigs occur at high enough densities in many forested areas that rooting and wallowing damage is common and can be quite severe locally. Depredation on agricultural crops is also a problem, especially in southern Guam. Controlling the effects of pig damage is recognized as an important measure to protect native forest and agricultural resources. Recreational harvest is the primary tool used to control pig numbers and current hunting regulations allow for a year-round season with bag limits of 2 pigs per day and 40 per year. There is a need to consider more liberal regulations to control pig populations island-wide and in localized areas.

OBJECTIVES

To monitor trends in pig population size and hunter participation and harvest.

PROCEDURES

1. Monitor hunter participation and harvest during the legal hunting season.
2. Collect biological data from animals killed during the hunting season and from incidental sources such as road kills or confiscated animals.

RESULTS

Pig Hunting Statistics

Hunter questionnaires were discontinued in FY96 because of a lack of manpower and low return rates, which may have resulted in biased sampling of the hunter community. Proposed revisions to hunting regulations may remedy this problem by requiring hunters to complete a questionnaire for the previous season prior to purchase of a new license.

Records of hunting activity and harvest were kept by officials at AAFB and NCTAMS during the year (Table 1). According to hunter logs from AAFB, 2,287.7 hunter-days (3,868 sorties; gun hunting only) were expended at Northwest Field and resulted in the harvest of 268 pigs. Hunting areas on the main portion of the base (Munitions Storage Area, Tarague basin, and areas near the landfill and to the north and east of the flightline) recorded 564 hunter-days (1,396 sorties; primarily bow hunting), with 136 pigs killed. At Andersen South, 33.5 hunter-days (105 sorties; bow hunting only) were registered, with 8 pigs taken. At NCTAMS, a minimum of 464.3 hunter-days (1,070 sorties) were expended, with a kill of 45 pigs. These records indicate a total harvest of 457 pigs on military lands.

Table 1. Hunter effort and wild pigs taken on Andersen Air Force Base and Naval Computer and Telecommunications Area Master Station (NCTAMS) during FY '97, based on official hunter logs.

	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sept.	Total
Andersen Air Force Base													
<u>Northwest Field</u> (gun hunting only)													
No. hunter sorties	732	685	728	92	109	191	147	141	155	166	2	720	3868
No. hunter days (8 hr)	452.1	396.1	498.0	39.9	45.5	72.1	59.3	56.8	65.9	75.3	1.0	525.7	2287.7
Pigs taken	31	32	46	8	19	24	20	19	13	22	0	34	268
Days effort/take	14.6	12.4	10.8	5.0	2.4	3.0	3.0	3.0	5.1	3.4	-	15.5	78.2
<u>Main Base</u> (primarily bow hunting)													
No. hunter sorties	126	195	224	70	19	62	55	67	58	85	100	335	1396
No. hunter days (8 hr)	47.0	72.1	86.9	26.4	7.3	25.3	22.3	28.0	27.0	38.3	42.8	140.6	564
Pigs taken	8	9	6	13	4	13	11	12	12	13	20	15	136
Days effort/take	5.9	8.0	14.5	2.0	1.8	1.9	2.0	2.3	2.3	2.9	2.1	9.4	55.1
<u>Andersen South</u> (bow hunting only; closed October-April)													
No. hunter sorties	-	-	-	-	-	-	-	19	11	33	16	26	105
No. hunter days (8 hr)	-	-	-	-	-	-	-	7.1	2.9	9.4	6.0	8.1	33.5
Pigs taken	-	-	-	-	-	-	-	1	2	0	2	3	8
Days effort/take	-	-	-	-	-	-	-	7.1	1.5	-	3.0	2.7	14.7
<u>NCTAMS</u> (gun and bow hunting; closed June 3-September 30)													
No. hunter sorties	205*	136	197	135	138	97	73	81	8	-	-	-	1070*
No. hunter days (8 hr)	85.9*	59.5	86.2	59.1	60.4	42.4	31.9	35.4	3.5	-	-	-	464.3*
Pigs taken	5*	8	11	4	6	6	4	1	0	-	-	-	45*
Days effort/take	17.2*	7.4	7.8	14.8	10.1	7.1	8.0	8.9	-	-	-	-	81.3*

*data incomplete for first 10 days of September

Survey Results

In November, staff of the DAWR assisted the U.S. Fish and Wildlife Service with a large mammal survey of Ordnance Annex (Walker et al. 1996). Survey methodology replicated that used by Biosystems Analysis Inc. (1989) in a previous study. In contrast to deer (*Cervus mariannus*) and carabao (*Bubalus bubalis*), transect results showed a no increase ($P = 0.828$) in pig sign from 1989 to 1996. Pig sign was most common in degraded ravine forest habitats.

RECOMMENDATIONS

Continue to monitor the annual pig harvest and hunter participation. Coordinate accurate record keeping and reporting of hunter effort and harvest at military bases.

PROGRAM COST

The estimated cost of the wild pig project under W-1R-5 is \$37,000.

LITERATURE CITED

- Biosystems Analysis, Inc. 1989. Natural resources survey for the U.S. Naval Magazine, Guam (NavMag). Naval Facilities Engineering Command, Pearl Harbor, Hawaii.
- Conry, P. J. 1988. Ecology of the wild (feral) pig (*Sus scrofa*) on Guam. Tech. Rept. No. 7. Div. Aquatic and Wildl. Res., Dept. Agric., Mangilao. 60 pp.
- Division of Aquatic and Wildlife Resources. 1967-1996. Job Progress Report - Federal Aid to Fish and Wildlife Restoration. Guam Dept. Agric., Mangilao.
- Walker, R., G. J. Wiles, J. M. Morton, M. R. Lusk, and A. P. Marshall. 1996. Large mammal surveys on the Ordnance Annex. pp. 109-131 in U. S. Fish and Wildlife Service. Faunal survey for the Ordnance Annex, Naval Activities, Guam. U.S. Fish Wildl. Serv., Honolulu, Hawaii.

Report was prepared by: Dana T. Lujan and Gary J. Wiles

JOB PROGRESS REPORT RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: W-1R-5
SUB-PROJECT NO.: W-2
STUDY NO.: 1
JOB NO.: 2

JOB TITLE: Population Numbers and Distribution of Philippine Turtle-Doves (1460)

PERIOD COVERED: October 1, 1996 to September 30, 1997

SUMMARY

Counts of Philippine turtle-doves (*Streptopelia bitorquata*) during this year's spring bird surveys were significantly different ($p < 0.05$) from last year's counts. Eighteen routes recorded decreases, four recorded increases, and one recorded no changes in numbers of doves. A mean of one or more birds per station was recorded on the Northwest Field, Cross Island Road, and Cocos Island routes.

BACKGROUND

The Philippine turtle-dove was introduced to Guam by the Spanish during their early colonization of the region, circa 1771 (Baker 1951) and has been regulated as a game bird since approximately 1903 (Conry 1987). Up through the early 1960s, the turtle-dove was very common and found in large numbers in both northern and southern Guam. By the late 1960s, dove populations in southern and central Guam began to decline and have since stabilized at low levels. Populations in northern Guam declined in the late 1970s and early 1980s. Turtle-doves are now found in appreciable numbers in prime dove habitat on Northwest Field, Conventional Weapons Storage Area (CWSA) and elsewhere on Andersen Air Force Base and at moderate numbers in selected areas of central and southern Guam. A large population still remains on snake-free Cocos Island. Predation by the brown tree snake (*Boiga irregularis*) is the major cause of nest loss (Conry 1988) and this introduced pest is thought to be responsible for the population decline. Because of the decline in numbers and the extremely poor nesting success, the Department of Agriculture officially closed the turtle-dove hunting season as of March 28, 1987. The season will be reopened if nesting success improves and numbers recover to a level that can support recreational hunting.

OBJECTIVES

1. To determine present population levels and distribution, and monitor population trends.
2. To investigate nesting success and causes of nest failures.

PROCEDURES

1. Philippine turtle-doves are surveyed once or twice monthly during roadside-counts of all birds conducted by DAWR staff in three areas of northern Guam. The results of these surveys are reported in Job W-4-1-1.

Table 1. Numbers of Philippine turtle-doves recorded per count and average numbers of birds per station, as detected in spring bird surveys at various locations on Guam during May 1997. Values in the trend column are the difference between the average station count between years.

Survey Location	No. Stations	No. Doves Observed	1997 Ave./ Station	1996 Ave./ Station	Trend in Ave. 97-96
NORTH SURVEYS					
Tarague	10	0	0.00	0.20	-0.20
CWSA	10	9	0.90	0.50	0.40
NWF	10	12	1.20	1.0	0.20
NCTAMS	10	3	0.30	0.40	-0.10
Capitol Improvement Road	10	3	0.30	0.00	0.30
MT. Santa Rosa	10	9	0.30	0.50	-0.20
Y-Sengsong Road	10	3	0.30	0.90	-0.60
Two Lover's Point	10	2	0.20	0.30	-0.10
Andersen South	10	2	0.20	0.30	-0.10
Navy Golf Course Barrigada	10	1	0.10	0.40	-0.30
Barrigada Hill	10	0	0.0	0.40	-0.40
Toto Pipeline	8	0	0.0	0.50	-0.50
SOUTH SURVEYS					
Nimitz Hill	10	1	0.10	0.20	-0.10
Reserve Craft Beach Road	4	2	0.50	0.50	0.0
Orote Point	6	2	0.33	0.67	-0.37
Pulantat	10	4	0.40	0.60	-0.20
Cross Island Road	10	0	0.0	1.00	-1.00
Naval Magazine	10	1	0.10	0.40	-0.30
Umatac	10	0	0.0	0.60	-0.60
Dandan	10	1	0.10	0.00	0.10
Ija	8	2	0.25	0.88	-0.63
Merizo	8	4	0.50	0.38	-0.12
Cocos Island	10	27	2.70	1.40	-1.30

2. Philippine turtle-doves were additionally surveyed during spring bird counts conducted on 23 routes throughout the island in May. These surveys consisted of 5-minute station counts at up to 10 stations per route, with the number of birds seen or heard recorded at each station. Results are summarized as the average number of birds observed per station.

RESULTS

Spring Bird Surveys

Turtle-doves were recorded on 17 of 23 (74%) spring bird surveys conducted in 1997 (Table 1). Snake-free Cocos Island continues to have the highest count with an average of 2.70 birds detected per station. Northwest Field and Cocos Island are the only other routes averaging ≥ 1.0 bird per station. Of the 23 routes surveyed, 18 (78%) recorded decreases, 4 (17%) recorded increases, and 1 (4%) recorded no change in the numbers of birds recorded. There was a significant change in the pattern from last year's survey (Wilcoxon Signed-rank Test, $T_s = 67.0$, $Z = -1.936$, $p < 0.01$).

RECOMMENDATIONS

1. Continue spring bird surveys across Guam to monitor distribution, relative abundance and population trends of the Philippine turtle-dove.
2. Keep Philippine turtle-dove hunting season closed until nesting success improves and the population recovers.

PROGRAM COST

The estimated cost of the Philippine turtle-dove project under W-1R-5 is \$15,000.

LITERATURE CITED

- Baker, R.H. 1951. The avifauna of Micronesia, its origin, evolution, and distribution. University of Kansas Pub. 3(1):1-359.
- Conry, P.J. 1987. Ecology of the Philippine turtle-dove on Guam. Tech. Report No. 6. Div. Aquatic and Wildl. Res., Dep. Ag., Mangilao.
- Conry, P.J. 1988. High nest predation by brown tree snakes on Guam. Condor 90:478-482.

Report was prepared by: Celestino F. Aguon

JOB PROGRESS REPORT RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: W-1R-5
SUB-PROJECT NO.: W-2
STUDY NO.: 2
JOB NO.: 1

JOB TITLE: Population Size and Distribution of Black Francolin on Guam (1460)

PERIOD COVERED: October 1, 1996 to September 30, 1997

SUMMARY

Black francolin (*Francolinus francolinus*) were detected on 15 of 23 (65%) survey routes conducted on Guam. Ten routes had decreases, seven routes had increases, and six routes had no change in the numbers of francolin recorded per count. This pattern of change was statistically significant ($p < 0.005$) compared to FY96.

BACKGROUND

In 1961, 171 black francolin were introduced to southern Guam as part of the Foreign Game Bird Introduction Program of the U.S. Fish and Wildlife Service. Surveys conducted in 1980 indicated the population was adequately established in most parts of southern Guam to open a hunting season. Regulations were promulgated to open a one-month season in December 1981 with a 4-bird daily limit and a 20-bird season limit. Francolin populations continued to increase from 1980-1982, but hunting pressure remained low, probably because of the unfamiliarity of the hunting public with the sporting qualities of the bird. With the bird population increasing and little hunting pressure, the francolin season and bag limits were further liberalized in FY83 to a 2-month split season, one month in January and one month in July, and the bag limit was increased to 5 birds per day with no season limit. Revisions to the francolin season were again made in FY '90, extending the season from January 1 to February 28 and from July 1 to August 31. Francolin hunting has increased in popularity and Guam hunters are successfully harvesting birds during the open seasons. Regulations implemented in FY83 remain in effect with hunter participation and adherence to game laws monitored by spot checks by Division of Aquatic and Wildlife Resources biologists and conservation officers. During recent years, francolin populations have been well established and stable throughout southern Guam and in shrub-grass habitats in central and northern Guam.

OBJECTIVES

To determine current relative abundance and current distribution of black francolin on Guam and monitor population trends and hunter harvest.

PROCEDURES

1. Conduct annual island-wide spring bird surveys (station counts) to monitor distribution and status of francolin throughout the island.

RESULTS

Spring Bird Surveys

Black francolin were detected on 15 of 23 (65%) spring bird surveys conducted during May 1997 (Table 1). Ten survey routes had decreases, seven route had increases, and six routes had no change in the numbers of birds per count (DAWR 1996), which was a statistically significant pattern of change from last year (Wilcoxon Signed-rank Test, $T_s = 60.0$, $Z = -0.782$, $p < 0.005$). Francolin, were found on 9 of 11 surveys south of Route 4, which was no change from last year. They were found on 6 of 12 routes in northern Guam, a decrease of two from last year (DAWR 1996). The Merizo survey route had the highest station counts this year with an average of 6.50 birds/station (Table 1). The Umatac route recorded the largest increase in birds per station this year, with a mean increase of 2.60 birds/station.

RECOMMENDATIONS

1. Continue to monitor francolin population status, distribution, and hunter harvest.
2. Collect information on hunter participation, effort, harvest, and areas hunted.

PROGRAM COST

The estimated cost of the black francolin project under W-1R-5 is \$15,000.

LITERATURE CITED

Division of Aquatic and Wildlife Resources. 1996. Job Progress Report. Federal Aid to Fish and Wildlife Restoration. Div. Aquatic and Wildl. Res., Dep. Ag., Mangilao.

Report was prepared by: Celestino F. Aguon

Table 1. Numbers of black francolin observed per count and average number of birds observed per station as detected in spring game bird surveys at various locations on Guam during May 1997. Values in the trend column are the difference between the average station count between years. (Ave. = average)

Survey Location	No. Stations	No. Birds Observed	1997 Ave./ Station	1996 Ave./ Station	Trend in Average 97-96
NORTH SURVEYS					
Tarague	10	0	0.00	0.00	0.0
CWSA	10	0	0.00	0.00	0.0
NWF	10	5	0.2	0.30	0.2
NCTAMS	10	20	2.00	1.50	0.5
Capitol Improvement Road	10	0	0.00	0.50	-0.5
MT. Santa Rosa	10	0	0.20	0.00	0.2
Y Sengsong Road	10	0	0.00	0.00	0.0
Two Lover's Point	10	6	0.60	0.90	-0.3
Andersen South	10	5	0.00	0.50	-0.5
Navy Golf Course	10	16	1.60	2.50	-0.9
Barrigada Hill	10	7	1.00	1.50	-0.5
Toto Pipeline	8	0	0.00	0.25	-0.3
SOUTH SURVEYS					
Nimitz Hill	10	36	3.60	3.40	0.2
Reserve Craft Beach Road	4	0	0.00	0.00	0.0
Orote Point	6	7	1.16	1.17	-0.01
Pulantat	10	38	3.80	3.00	0.8
Cross Island Road	10	5	0.50	1.50	-1.0
Naval Magazine	10	12	1.20	1.90	-0.7
Umatac	10	53	5.30	2.70	2.6
Dandan	10	55	5.50	5.50	0.0
Ija	8	26	3.25	4.13	-0.9
Merizo	4	26	6.50	5.50	1.0
Cocos Island	10	0	0.00	0.00	0.0

JOB PROGRESS REPORT RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: W-1R-5
SUB-PROJECT NO: W-3
STUDY NO.: 1
JOB NO.: 1

JOB TITLE: Population Size and Distribution of Wild Asiatic Water Buffalo on Guam (1460)

PERIOD COVERED: October 1, 1996 to September 30, 1997

SUMMARY

Counts of feral Asiatic water buffalo (*Bubalus bubalis*) at Naval Ordnance Annex (NOA) showed no significant changes ($P > 0.05$) in number of animals recorded per km during FY97. The base's buffalo population has shown a general increasing trend since the late 1970s.

BACKGROUND

Asiatic water buffalo were introduced to Guam in the 1600s from the Philippines for use as beasts of burden (Wiles 1990). Known locally as carabao, these animals numbered about 2,000 prior to World War II. Many of the island's domestic animals were apparently let loose during the Japanese occupation, resulting in the creation of feral herds in the interior region of south-central Guam. The Division of Aquatic and Wildlife Resources (DAWR) began spotlight counts of carabao on NOA (formerly Naval Magazine) in 1966 while conducting Philippine deer (*Cervus mariannus*) censuses (Wiles 1990). The NOA herd averaged about 0.6-0.8 animals/km between 1966 and 1978 (Anderson 1980). Buffalo abundance peaked in 1982, when an average of 2.6 animals/km traveled was recorded. Population numbers decreased for several years thereafter, but increased again to 2.6 animals/km traveled in 1989 (DAWR 1983-1989). Biosystems Analysis Inc. (1989) estimated the carabao population on NOA to be 75-150 animals in 1987. In 1996, spotlight counts revealed an all time high of 2.8 animals/km traveled (DAWR 1996). Illegal hunting has been a major cause of mortality in the population (Conry 1988), but expanded anti-poaching efforts on the Annex by DAWR conservation officers and the Navy since the 1980s may be responsible for allowing the population to show steady growth. High buffalo densities have resulted in localized habitat damage on the base (Conry 1988, Biosystems Analysis Inc. 1989).

OBJECTIVES

To monitor the status of the feral Asiatic water buffalo on Guam and to determine if control measures are necessary to maintain the population at a level compatible with the available resources.

PROCEDURES

1. Conduct monthly spotlight counts on NOA. Analyze count data and compare with past data to estimate population trends.

2. Monitor carabao movements.

RESULTS

Spotlight Count Trends and Other Survey Results

Only five spotlight counts of water buffalo were made on NOA in FY97. The number of buffalo per count showed no significant change (Mann-Whitney *U*-Test, $U = 21$, $P > 0.10$) from last year, with an average of 2.8 animals/km seen in both years (Table 1). A mean of 65.4 animals was recorded per count this year. The largest number of buffalo recorded on a monthly count increased from 86 animals in FY96 to 108 animals in FY97.

Table 1. Results of monthly spotlight counts of feral water buffalo at the Ordnance Annex, FY97.

Month	No. animals observed	Km traveled	Animals/ km	Miles traveled	Animals/ mile
Oct	49	24.6	2.0	15.3	3.2
Nov	108	24.2	4.5	15.0	7.2
Jan	34	22.5	1.5	14.0	2.4
May	83	22.5	3.7	14.0	5.9
Jun	53	22.5	2.4	14.0	3.8
Total	327	116.3	-	72.3	-
Ave	65.4	23.3	2.8	14.5	4.5
SD	29.7	1.1	1.2	0.6	2.0

Analyses of spotlight counts from 1968-1997 for NOA (DAWR 1980-1996; this report) show an increasing trend in buffalo abundance (Figure 1). Counts were positively correlated (Pearson Correlation Coefficient $r = 0.777$, $P = 0.0001$, $n = 26$). Simple linear regression suggests that the rate of increase (slope) of buffalo is 0.069 (SE = 0.012) per year.

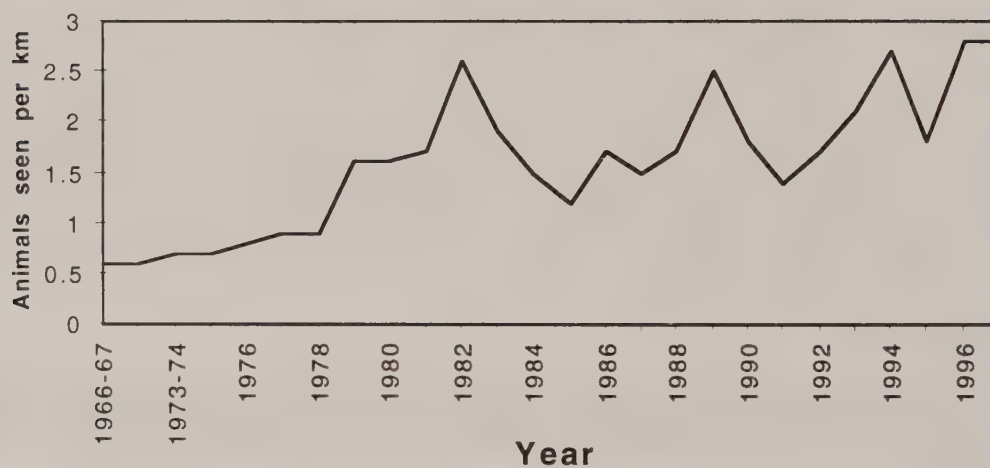


Figure 1. Results of water buffalo spotlight counts on Ordnance Annex from 1968-1997. Results are expressed as an annual mean of the number of animals seen per kilometer per count. Simple linear regression indicates that the rate of increase (slope) of buffalo is 0.069 (SE = 0.012) per year.

In November, DAWR staff assisted the U.S. Fish and Wildlife Service (USFWS) with a large mammal survey of NOA (Walker et al. 1996). Survey methodology replicated that used by Biosystems Analysis Inc. (1989) in a previous study. Transect results showed a two-fold increase ($P = 0.012$) in water buffalo sign from 1989 to 1996, indicating that an overall increase in animal numbers has occurred on the base. Buffalo sign was most common in degraded ravine forests and savanna and least common in undisturbed ravine forest. The survey found two additional population parameters to be higher in 1996 than 1989. These were a greater mean calf to adult ratio (2.4:10 in 1996 vs. 1:10 in 1989) and a much greater daylight count of absolute buffalo numbers (60 animals in 1989 vs. 134 animals in 1996) (Walker et al. 1996, Biosystems Analysis Inc. 1989). These data strongly suggest that buffalo numbers have increased on the base and corroborate population trend results seen in DAWR spotlight counts (Figure 1).

Based on absolute count results (134 animals; Walker et al. 1996) and information derived from counts of recognizable animals (see below), a reasonable estimate of the current water buffalo population size on NOA is 200-300 animals.

Immunocontraception of Water Buffalo

Jay F. Kirkpatrick of Zoo Montana in Billings, Montana, was contracted by the Navy to assess the viability of using immunocontraceptives to reduce the water buffalo population on NOA. Porcine zona pellucida (PZP) vaccine has been a successful contraceptive in a variety of wild ungulates (Kirkpatrick 1995; Turner et al. 1992). The contraceptive effects are reversible through at least three years of treatment. The vaccine is administered intramuscularly with an adjuvant using a dart gun. Target animals are initially treated with two inoculations given 3-6 weeks apart. A single booster (a third inoculation) will be administered 9 months after the initial treatment to determine if contraception can be sustained by annual booster vaccinations.

As part of this project, staff from the USFWS, DAWR, and Navy prepared an identification handbook of buffalo based on individual horn characteristics (31 females and 3 males were recognizable) and were trained in inoculation procedures. Twenty-four females were given the initial treatment of two inoculations from April 28 - May 6 and June 4 - 24. The single booster inoculation will be administered in March-April 1998. Follow-up observations of treated animals are being made on a weekly basis for signs of calving.

Other Activities

Preliminary studies on the movements of water buffalo on NOA are underway, based on the location of recognizable animals at least once a week. Behavior, social activity, weather, and time of day were also noted.

Several early morning sightings of small carabao herds were reported by the public along Route 17 in April. Tracks and/or dung were found near sightings. "Carabao Crossing" signs were posted along the highway in May to decrease the potential for automobile-carabao collisions. Two of the three signs were missing by late September, while the remaining sign had several bullet holes.

RECOMMENDATIONS

Continue spotlight counts on NOA. Collect data concerning buffalo movements.

PROGRAM COST

The estimated cost of the wild Asiatic water buffalo project under W-1R-5 is \$4,000.

LITERATURE CITED

- Anderson, R.D. 1980. Population size and distribution of wild carabao on Guam. Job Progress Report. Federal Aid to Fish and Wildlife Restoration, Guam. Guam Dept. Agric., Mangilao, Guam.
- Biosystems Analysis, Inc. 1989. Natural resources survey for the U. S. Naval Magazine, Guam (NavMag). Naval Facilities Engineering Command, Pearl Harbor, Hawaii.
- Conry, P.J. 1988. Management of feral and exotic game species on Guam. Trans. West. Sec. Wildl. Soc. 24:26-30.
- Division of Aquatic and Wildlife Resources. 1980-1996. Job Progress Reports. Federal Aid to Fish and Wildlife Restoration, Guam. Guam Dept. Agric., Mangilao, Guam.
- Kirkpatrick, J.F. 1995. Management of Wild Horses by Fertility Control: The Assateague Experience. Natl. Park Serv. Scientific Monogr., Natl. Park Serv., Denver, Co.
- Turner, J.W., Jr., I.K.M. Liu, and J.F. Kirkpatrick. 1992. Remotely delivered immunocontraception in captive white-tailed deer. J. Wildl. Manage. 56:154-157.
- Walker, R., G. J. Wiles, J. M. Morton, M. R. Lusk, and A. P. Marshall. 1996. Large mammal surveys on the Ordnance Annex. pp. 109-131 *in* U. S. Fish and Wildlife Service. Faunal survey for the Ordnance Annex, Naval Activities, Guam. U. S. Fish Wildl. Serv., Honolulu, Hawaii.
- Wiles, G.J. 1990. Population size and distribution of wild Asiatic water buffalo on Guam. Job Progress Report. Federal Aid to Fish and Wildlife Restoration, Guam. Guam Dept. Agric., Mangilao, Guam.

Report was prepared by: Dana T. Lujan and Gary J. Wiles

JOB PROGRESS REPORT RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: W-1R-5
SUB-PROJECT NO.: W-4
STUDY NO.: 1
JOB NO.: 1

JOB TITLE: Survey and Inventory of Non-Game Birds (1460)

PERIOD COVERED: October 1, 1996 to September 30, 1997

SUMMARY

Seven species of resident and migrant birds were recorded on roadside counts in northern Guam. Censuses of island swiftlets (*Collocalia bartschi*) at Mahlac Cave indicated that the population increased from about 280 to 350 birds during the year. A much smaller count of 31 birds was made at Fachi Cave. Seven Mariana crows (*Corvus kubaryi*) were detected in the annual crow survey. The estimated number of crows remaining in the Guam population is 16 birds, which is a slight increase over last year. This increase was achieved through the release into the wild of four translocated zoo birds and two hand-reared birds. A small artificial nest box program for Micronesian starlings (*Aplonis opaca*) was started in the main housing area on Andersen Air Force Base (AAFB) this year.

BACKGROUND

Predation by brown tree snakes (*Boiga irregularis*) is the major factor in the decline of most of Guam's native bird species during the last few decades (Savidge 1987, Conry 1988, Engbring and Fritts 1988). Census data from a variety of sources have documented the extirpations of eight species, while four others have undergone severe population decreases, both in terms of overall numbers and geographic range (Division of Aquatic and Wildlife Resources [DAWR] 1963-1996, Engbring and Ramsey 1984, Wiles et al. 1995).

Common moorhens (*Gallinula chloropus guami*) continue to be scattered throughout the southern and central parts of Guam, with recent population estimates placed at 100-125 birds (Stinson et al. 1991). Island swiftlets occur primarily in one large colony on Naval Ordnance Annex (formerly Naval Magazine). Three much smaller colonies are also known and occur on the Ordnance Annex, in the Lumuna district of Yigo, and in the vicinity of the Geus River Valley in Merizo (DAWR 1987-1995, Wiles et al. 1995). Mariana crows are now restricted to AAFB (DAWR 1992-1996, Wiles et al. 1995). Their population declined to an estimated 14 birds in 1996 (DAWR 1996). Two small populations of Micronesian starlings also persist on the island, with most birds remaining on AAFB and Yigo, while smaller numbers occur on Cocos Island and coastal areas of southern Guam (DAWR 1991-1996, Wiles et al. 1995). Recovery plans have been written for each of these species except the starling (Beck and Savidge 1990, US Fish and Wildlife Service 1991a, 1991b). In addition, the island continues to retain small to moderate numbers of several other resident bird species, as well as migratory shorebirds, seabirds, and waterfowl.

OBJECTIVES

To continue status surveys and natural history studies as called for in the recovery plans for Guam's endangered native birds (Beck and Savidge 1990, US Fish and Wildlife Service 1991a, 1991b).

PROCEDURES

1. Roadside counts were conducted at bi-weekly intervals on three routes (North, North-Central, and Northwest Field; see previous annual reports for locations of routes) in northern Guam by DAWR conservation officers. These routes were driven at approximately 15-25 kph beginning at sunrise. Numbers and species of all birds seen or heard were recorded, irrespective of the distance from the observer.
2. Monthly visits to Mahlac Cave on Ordinance Annex were made to monitor the island swiftlet colony. When counts were conducted, observers sat at both entrances of the cave for a period of 1-2 hours before dark and recorded the numbers of birds flying in and out. The total number of birds inhabiting the cave was determined by subtracting the number of departures from the number of arrivals and by adding the number of birds estimated to be in the cave at the start of the count. During all visits, observers entered the cave for about 1 hr (prior to any counts) to record numbers of nestlings and listen for their calls. In order to avoid disturbing nesting birds, nests were viewed from a slightly elevated position off to the side of the cave rather than by using a mirror to look inside the nests. The cave floor was searched and cleaned each month of eggshell fragments and whole eggs that had fallen from nests overhead in the guano.
3. Recorded-call playback surveys for Mariana crows were conducted in northern Guam. At each station, tape-recorded calls were played for 2.5 minutes. This was followed by a 2-minute silent period during which the observer listened for crows. The numbers, distance, and plumage condition of the crows observed were recorded.

RESULTS

Roadside Counts

Roadside counts continue to document the status of birds in northern Guam. Six species were observed on each of the three count routes in FY97 (Table 1). On the North route, four species (yellow bittern [*Ixobrychus sinensis*], Pacific golden plover [*Pluvialis fulva*], Philippine turtle-dove [*Streptopelia bitorquata*], black drongo [*Dicrurus macrocercus*]) showed increases in abundance this year. Three species (Philippine turtle-dove, black drongo, and Eurasian tree sparrow [*Passer montanus*]) were more numerous along the Northwest Field route, however, one species (Mariana crow) recorded in FY96 was not detected this year. The North-Central route also had three species (black francolin [*Francolinus francolinus*], black drongo, and Eurasian tree sparrow) that were more common this year.

Dr. Jonathan Bart of the USGS Biological Resources Division analyzed trends in Guam's roadside count results dating back to mid-1970s. His findings were presented at the Cooper Ornithological Society's annual meeting in Hilo, Hawaii in May. A manuscript detailing the results will be prepared during the upcoming year, with several DAWR staff biologists co-authoring the report (R.E. Beck et al., in prep.).

Table 1. Results of North, Northwest Field, and North-Central roadside counts in FY97, showing the species and mean ($\pm$ SD) number of birds recorded per 100 km of travel.

Species	North		Northwest Field		North-Central	
	No. per 100 km	SD	No. per 100 km	SD	No. per 100 km	SD
Yellow bittern	11.1	14.3	4.4	2.8	4.8	2.0
Black francolin	8.0	4.7	0.0	0.0	16.1	3.9
Pacific golden plover	28.8	11.4	91.6	18.6	46.5	9.0
Brown noddy	0.0	0.0	1.3	0.6	0.0	0.0
Philippine turtle-dove	16.1	4.8	29.1	4.0	15.7	3.1
Black drongo	18.1	6.1	24.4	3.4	10.9	3.8
Eurasian tree sparrow	48.5	16.5	7.8	3.5	213.3	42.0
Number of counts	20		18		19	

Common Moorhens

The DAWR did not conduct moorhen surveys at the Fena Reservoir in FY97. However, five counts were made by staff of the US Fish and Wildlife Service (USFWS) (M. Ritter, pers. comm.). Survey results were as follows: January, 19 birds (adults and juveniles combined); February, 18 birds; March, 24 birds; April, 27 birds; and May, 19 birds. As in previous years, nearly all moorhens were recorded in the southern half of the reservoir. Two active nests were located in February, while chicks were seen during January, March, and April.

Moorhen records of special interest during the year included the following: 1) two adults and a possible juvenile seen at the small wetland on Tiyan (formerly Naval Air Station) near Route 8 on 12 April, and 2) a subadult found injured along the side of Route 15 in the Pinate area of Mangilao on 15 August. Because the latter area has no known wetlands, the bird was possibly dispersing to suitable habitat.

Island Swiftlets

Mahlac Cave - Swiftlet numbers at this site showed some recovery in FY97 after experiencing a sudden decline from about 495 to 280 birds in FY96 (DAWR 1996). Censuses made between early February and late April 1997 indicated that numbers grew from about 315 birds to 350 birds (Table 2). A much higher count of 411 swiftlets was obtained on 1 April, but was assumed to be erroneous based on the large difference between it and other counts during the year. A final census on 28 August also tallied approximately 350 birds. Count results therefore suggest that the *Mahlac Cave* population has increased by about 70 birds, or 25%, since last year.

Snake trapping was not conducted at the cave this year by either the USFWS or DAWR. One live snake was captured by hand on 30 April. It was a male with a snout-vent length of 111.0 cm, a total length of 130.5 cm, a weight of 182 gr, and a body fat weight of 11.65 gr. Its stomach and intestine were empty. On 6 May, a snake pellet containing swiftlet feathers was found on the ground just outside the cave's south entrance.

Reproductive activity in the colony was monitored again this year. Nesting seasonality generally agreed with observations from previous years (DAWR 1987-1996), with the greatest egg and chick production occurring from February through August (no observations made during September). However, the nesting season appeared to be delayed by about a month this year, with most egg laying and chick hatching not starting

until late January or February. Reasons for the delay were not readily apparent, but were possibly related to greater than normal rainfall during January.

Table 2. Results of censuses for island swiftlets at Mahlac and Fachi Caves on Ordnance Annex during FY97. Evidence of reproductive activities of swiftlets is also presented.

Date	Reproductive Parameters								
	Net No. of Birds Entering Cave	No. of Birds Estimated in Cave at Start of Count	Total No. of Birds Counted	No. of Whole Eggs Found on Cave Floor	No. of Eggshell Fragments on Cave Floor	No. of Nestlings Heard	No. of Nestlings Seen		
							small	med	large
<u>Mahlac Cave</u>									
7 October 1996	-	-	-	1	5	3-4	1	2	5
31 October	-	-	-	2	2	2-3	2	2	2
26 November	-	-	-	0	2	2-3	0	2	2
3 January 1997	-	-	-	1	0	0	0	0	0
31 January	-	-	-	0	1	1	3	0	0
6 February	299	16	315	-	-	-	-	-	-
27 February	330	6	336	3	9	5+	9	7	2
1 April	386	25	411	1	16	3-4	2	7	10
30 April	330	20	350	3	14	3-4	5	3	4
30 May	-	-	-	2	31	many	10	3	11
30 June	-	-	-	6	23	2-3	1	5	13
30 July	-	-	-	4	17	2-3	4	8	4
28 August	330	19	349	1	14	2-3	2	14	7
<u>Fachi Cave</u>									
23 June 29	2	31	0	-	-	0	-----	7-----	

Key: - = no data gathered.

The USFWS continued its study of monitoring swiftlet nesting activity and snake presence in the cave using a video camera system. Data analyses are now underway.

In February, the DAWR and USFWS installed eight artificial nest structures in Mahlac Cave to test whether they might be used as nesting substrate by swiftlets. This experiment was conducted because of the consideration that the cave's swiftlet population perhaps may be limited by a lack of available natural nest attachment sites in snake-free areas. Four types of nest mounts were built from the following material: 1) a modified plastic drinking cup holder, 2) a modified plastic screw-in pipe cap, 3) a plastic water bottle cut down to form a lipped hoop, and 4) a piece of hardened spray insulating foam resembling a rounded stalactite. The mounts were glued to the cave ceiling in two groups, both containing each type of mount, within 1-2 m of existing natural nests. All of the mounts remained attached to the ceiling through September, but none had nest material added to them. However, video-taping photographed three instances of swiftlets roosting on mounts (J. Morton, pers. comm.). Two of these were of birds sitting for short intervals, however, in the third case, a bird roosted on a foam mount for most of one night (from 2100-0600 hrs).

Fachi Cave - Flooding affected swiftlet use of Fachi Cave on four occasions this year, the most since work began at the cave in 1990. High water levels were recorded in late September 1996 (DAWR 1996) and probably remained moderately high into October, although no actual observations were made. Heavy rains associated with the passage of Typhoon Dale on 7-8 November apparently closed off the entrance entirely, based on the presence of debris sticking to rocks over the entrance. Water levels dropped to 15 cm and 51 cm below the entrance top on 13 and 22 November, respectively. On 31 January, water was again within 5 cm of the entrance top following 20 cm of rain in the latter part of the month. The level fell to 51 cm below the entrance top on 4 February. Entry into the

cave in the late afternoon that day revealed an estimated 10-30 birds roosting in the cave's nesting chamber. An extremely high record rainfall of 98 cm for August closed the cave entirely on 20 August. The water level was 8 cm below the entrance top on 22 and 25 August, but the cave was again closed from 28 August to 4 September. Water levels were 20 cm below the entrance top by 8 September and continued to fall into mid-October, when the cave was found to be relatively free of water.

A census of 31 swiftlets was made at Fachi Cave on 23 June (Table 2), which is slightly larger than counts obtained last year (DAWR 1996). It is not known how long the birds abandon the cave for during flooded conditions, nor how quickly they recolonize it after the water level falls. Swiftlets continued to fly down and closely investigate the cave's main entrance during August and early September, when the water level was high for an extended period. The birds circled 1-4 m in front of the entrance at a height of 0.5-1.5 m over the water's surface.

Firebreak 3 Cave - Visits to this cave revealed that it continued to remain unoccupied after the decline at Mahlac Cave.

Mariana Crows

Fourteen transects totaling 211 stations were used to survey crows in eight regions of northern Guam during July (Figure 1). Birds were present on two transects, which is a slight increase from last year. A total of seven crows were recorded during the survey (Table 3), including six birds in the Conventional Weapons Storage Area (CWSA) and one bird in the C3 area of Northwest Field. This number is much lower than the actual number of birds still surviving in the wild (Table 3). Six crows were recorded on Transect 1, but three other birds known in the area were not detected. Five of these birds were individuals released into the wild during 1997. They included four Rota crows transferred to the DAWR from the National and Houston Zoos and released from March to June, and a hand-reared Guam crow released in January. Unfortunately, the hand-reared bird was found dead on August 22, reducing the number of crows in the CWSA to eight birds.

Table 3. Summary of results from playback of tape-recorded Mariana crow calls conducted in July 1997. Transect locations are shown in Figure 1.

<u>Transect</u>	<u>No. of stations</u>	<u>No. of crows detected</u>	<u>No. of stations with crows</u>	<u>Known no. of crows missed in survey</u>
1	50	6	4	3
2	36	0	0	1
3	12	0	0	0
4	10	0	0	0
5	8	0	0	0
6	11	0	0	0
7	10	0	0	3
8	23	0	0	0
9	9	0	0	1
10	9	0	0	0
11	7	0	0	0
12	9	0	0	0
13	8	1	1	0
14	9	0	0	2
Total	211	7	5	10
July crow population estimate = 7 + 10 = 17 birds				

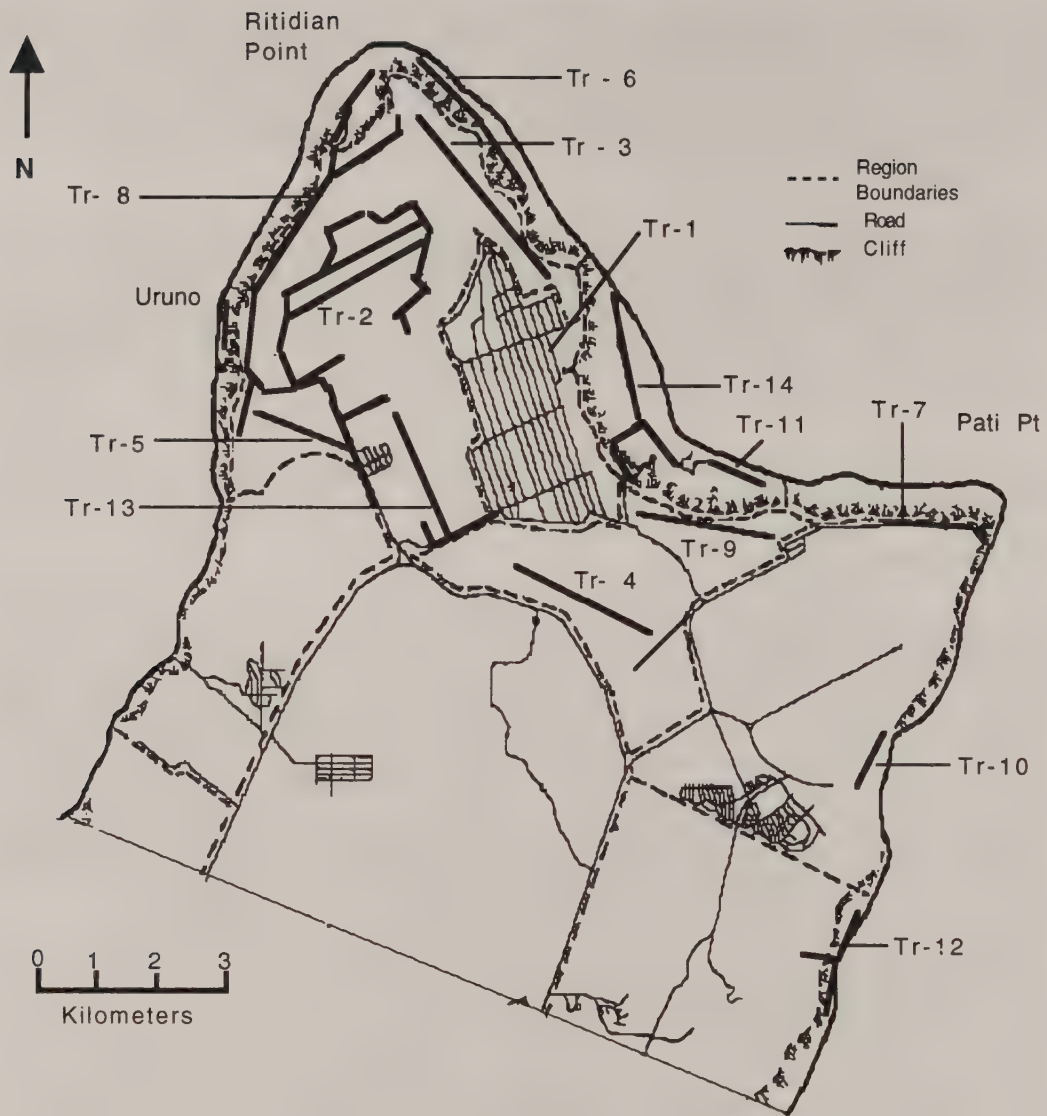


Figure 1. Locations of Mariana crow survey transects in northern Guam.

No birds were recorded on Transect 7 in the vicinity of Pati and Tagua Points, where four individuals are known to reside (Figure 2). The Tarague region still harbors one pair of birds, but both individuals were missed in the survey. This pair is known to fly fairly long distances between the CWSA and Tarague basin (Figure 2). No crows were recorded in Northwest Field, where a hand-reared female from Guam was released in February. Unfortunately, her transmitter failed in late April and there have been no subsequent sightings. Her status remains unknown.

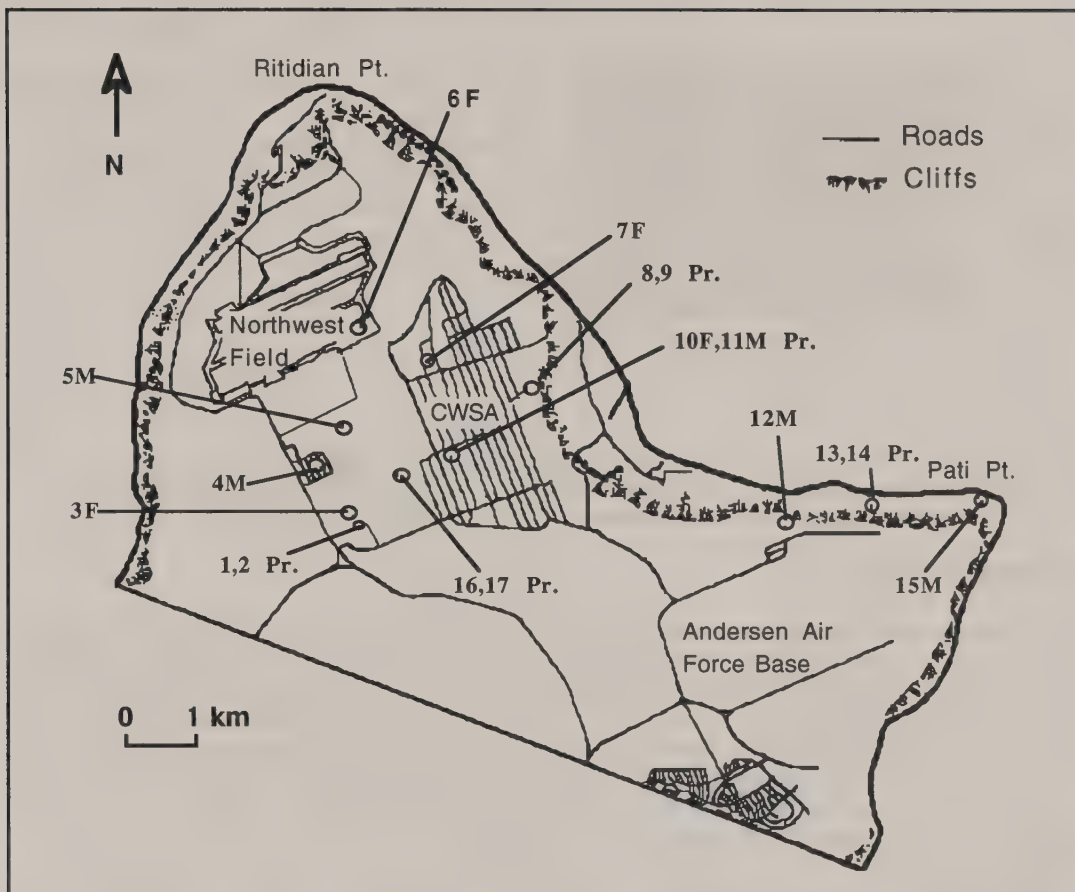


Figure 2. Locations of known crows (in circles) in Northwest Field, the Conventional Weapons Storage Area (CWSA), and at Pati Point in July 1997. Each location is noted as a male (M), female (F), or pair (Pr). Pair 1, 2 was composed of a hand-reared Guam male (named "Joga") and a translocated zoo female. Unfortunately, the male died in August. The status of the second hand-reared Guam crow (6F, named "Nunu") is unknown. Four translocated zoo crows were present in July, including 2F ("Fadang"), 4M ("Ahgao"), 7F ("Pengua"), and 10F ("Faia"). Two other translocated zoo crows, a male and female, died prior to the survey.

Guam's crow population is estimated at 16 birds at the end of September 1997. This figure is derived from the numbers of birds recorded and missed during the July survey, minus the known death of one bird in August. This estimate represents a 14% increase over last year's estimate, but was achieved only with the release of the four zoo birds. Guam's crow population continues to be very small (Figure 3). The population will not survive much longer without additional translocations of birds from Rota.

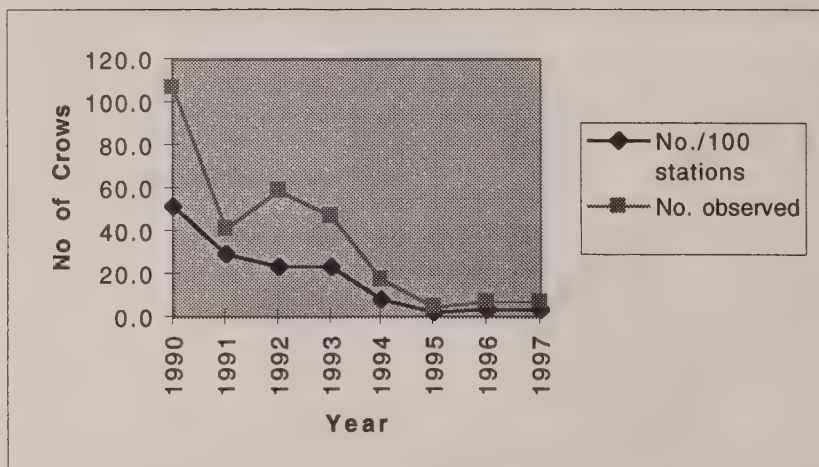


Figure 3. Results of annual playback surveys for Mariana crows conducted on Guam from 1990-1997. The 1997 estimate includes four translocated zoo crows released in the wild in FY97.

Micronesian Starlings

Six nest boxes made of plywood were erected for starlings by the Air Force and a Boy Scout troop in October and November. Two box designs were used. One was made with a roof and a large entry hole on the upper side of one wall and the second had an open top that functioned as the entry hole. All of the boxes were placed on the trunks of coconut trees about 1-1.3 m below the crown. Areas of known starling occurrence in the base's main housing area were selected for box sites. Boxes were checked fairly regularly for starling use from November to June, but no activity was recorded. The Air Force has agreed to continue monitoring the boxes in FY98 and erect a third type of box made of PVC piping.

Two starling nests were located in trunk cavities of flame trees (*Delonix regia*) this year. Both cavities occurred where dead branches (about 10-15 cm in diameter) had fallen off the main trunk, which allowed a hole to eventually form through wood rot.

Notable Species Recorded on Guam During FY97

Noteworthy records of birds for Guam in FY97 are presented here. A Matsudaira's Storm Petrel (*Oceanodroma matsudairea*) and an Audubon's Shearwater (*Puffinus lherminieri*) were captured by the public in Agat on 30 July and at an unreported location on 6 August, respectively, and turned over to the DAWR. A group of about 25 Brown Boobies (*Sula leucogaster*) roosted on Orote Point Island for at least several months from June to August. This is the largest aggregation of this species known to roost on Guam since at least the 1970s. Follow-up observations should be made to determine whether nesting may have occurred. Two Red-tailed Tropicbirds (*Phaethon rubricauda*) were sighted at Pati Point on 21 December.

The year's most unusual bird record was a male Surf Scoter (*Melanitta perspicillata*) found by a fisherman outside the reefline at Two Lovers Point on 2 January. This species had not been previously recorded in Micronesia. Its normal range is the Pacific Northwest. Unusually high total numbers of 69 Northern Pintails (*Anas acuta*) and 61 Tufted Ducks (*Aythya fuligula*) were seen at several wetlands on 21 December. A Chinese Goshawk (*Accipiter soloensis*) was observed twice in the eastern Talofofo River Valley on 3 and 16

October. Two reports of an unidentified hawk on Nimitz Hill came from the public in late October and early November.

Snowy Plovers (*Charadrius alexandrinus*) were found at Togcha Beach on 15-16 November (1 bird), at Duncas Beach on 24 November (1 bird) and 1 January (1 bird), and at Tiyan on 1 January (1 bird) and 18 January (2 birds). A flock of seven Black-winged Stilts (*Himantopus himantopus*) was observed on Tiyan at a small pond on 18 September, representing the largest number of stilts ever recorded together on Guam. A Common Redshank (*Tringa totanus*) was sighted at Tiyan on 28-30 August. A leg-flagged Gray-tailed Tattler (*Heteroscelus brevipes*) was seen at the Merizo sewage treatment ponds on 21 December. The bird was tagged at Furen Lake, Nemuro City, Hokkaido, Japan (43°16' N, 144°40' E) (Y. Shigeta, Yamashina Institute for Ornithology, pers. comm.). A Eurasian Curlew (*Numenius arquata*) was found at Camp Covington, Piti on 21 December. A Bristle-thighed Curlew (*N. tahitiensis*) was sighted on a tidal reef flat between Nimitz Beach and Facpi Point in Agat on 9 March. A pair of Black-tailed Godwits (*Limosa limosa*) resided in the vicinity of Duncas Beach from 24 November until 13 May, when one of the birds was found injured. A necropsy revealed that it had heavy fat deposits, but had a chipped sternum and a hematoma on the breast, indicating that it probably collided with an object. The remaining godwit overwintered on Guam and was last seen at Tiyan on 30 August. A Temminck's Stint (*Calidris temminckii*), a new record for Guam, was observed with four Long-toed Stilts (*C. subminuta*) in a grassy field at Tiyan on 2 January. A single Dunlin (*C. alpina*) was seen at Duncas Beach from 24 November to 15 February. Solitary Curlew Sandpipers (*C. ferruginea*) were noted at Ordnance Annex on 10-11 October and at Tiyan on 30 August. Single Pectoral Sandpipers (*C. milanotos*) were observed in the 12 Group at Ordnance Annex on 13 November and at Tiyan on 24-25 November and 1 January. A particularly large number of seven Ruffs (*Philomachus pugnax*) were sighted at Tiyan on 27-30 August, with five still present on 18 September.

Two Whiskered Terns (*Chlidonias hybridus*) were recorded at the Agfayan Bay fishponds in Inarajan on 6 October. Another was seen in inner Apra Harbor on 21 December. A Hill Myna (*Gracula religiosa*) was recorded for at least several weeks on NCTAMS in January. A pair of these mynas was also observed near Building 21000 on AAFB in early and late July.

Two papers were published during the year on the occurrence of migratory shorebirds, waterbirds, and land birds (Stinson et al. 1997a, b).

RECOMMENDATIONS

1. Develop and implement methods for controlling the brown tree snake.
2. Continue to monitor the population of common moorhens and develop an appropriate habitat improvement and development program.
3. Continue monthly cave censuses and efforts to assess population change and reproductive activity of island swiftlets. Consider snake-proofing Mahlac Cave to protect nesting swiftlets. Conduct further observations on the foraging behavior of swiftlets. Determine whether there is any seasonal variation in the foraging range of the colony. Interview farmers in the Talofoto River valley about the use of pesticides on their farms.
4. Continue to census the Mariana crow in order to estimate population size and distribution. Continue breeding biology studies and attempts to snake proof nest sites of crows.
5. Continue predator control efforts on Cocos Island until complete eradication of monitor lizards and feral cats is attained.

6. A review of ongoing and completed wetland mitigation projects should be made to assess the success of these projects. The evaluation should be done in cooperation with other Government of Guam agencies, the US Army Corps of Engineers, the USFWS, and private sector consultants.

PROGRAM COST

The estimated cost of the non-game bird project under W-1R-5 is \$45,000.

LITERATURE CITED

- Beck, R.E., Jr. and J.A. Savidge. 1990. Recovery plan for the native forest birds of Guam and Rota. US Fish Wildl. Serv., Portland, Or. 86 pp.
- Conry, P.J. 1988. High nest predation by the brown tree snake on Guam. Condor 90:478-482.
- Division of Aquatic and Wildlife Resources. 1963-1996. Job Progress Reports - Federal Aid to Fish and Wildlife Restoration. Guam Dept. Agric., Mangilao.
- Engbring, J. and T.H. Fritts. 1988. Demise of an insular avifauna: the brown tree snake on Guam. Trans. West. Sec. Wildl. Soc. 24:31-37.
- Engbring, J. and F.L. Ramsey. 1984. Distribution and abundance of the forest birds of Guam: results of a 1981 survey. US Fish Wildl. Serv., Washington, D.C. FWS/OBS-84/20.
- Savidge, J.A. 1987. Extinction of an island avifauna by an introduced snake. Ecology 68:660-668.
- Stinson, D.W., M.W. Ritter, and J.D. Reichel. 1991. The Mariana common moorhen: decline of an island endemic. Condor 93:38-43.
- Stinson, D.W., G.J. Wiles, and J.D. Reichel. 1997a. Occurrence of migrant shorebirds in the Mariana Islands. J. Field Ornithol. 68:42-55.
- Stinson, D.W., G.J. Wiles, and J.D. Reichel. 1997b. Migrant land birds and water birds in the Mariana Islands. Pacific Sci. 51:314-327.
- Tarr, C. L. and R. C. Fleischer. 1995. A molecular assessment of genetic variability and population differentiation in the endangered Mariana crow (*Corvus kubaryi*). Natl. Zool. Park, Smithsonian Instit., Washington, D.C. Unpublished.
- US Fish and Wildlife Service. 1991a. Recovery plan for the Mariana Islands population of the Vanikoro swiftlet (*Aerodramus vanikorensis bartschi*). US Fish Wildl. Serv., Portland. 49 pp.
- US Fish and Wildlife Service. 1991b. Recovery plan for the Mariana common moorhen (=gallinule), *Gallinula chloropus guami*. US Fish Wildl. Serv., Portland. 55 pp.
- Wiles, G.J., C.F. Aguon, G.W. Davis, and D.J. Grout. 1995. The status and distribution of endangered animals and plants in northern Guam. Micronesica 28:31-49.

Report was prepared by: Gary J. Wiles and Celestino F. Aguon

JOB PROGRESS REPORT RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: W-1R-5
SUB-PROJECT NO.: W-4
STUDY NO.: 1
JOB NO.: 2

JOB TITLE: Survey for Mariana crows and their nest sites (1460, 1470)

PERIOD COVERED: October 1, 1996 to September 30, 1997

SUMMARY

Based on Mariana crow, *Corvus kubaryi*, call surveys and locations of known individuals, the crow population on Guam was estimated at 16 birds. This number includes four Rota crows released on Guam that are still surviving. Only a single nest was found during the breeding season, but no eggs were produced.

BACKGROUND

The Mariana crow is found only on Guam and Rota and is the only species of crow in Micronesia. Though once found throughout Guam, surveys in 1981 estimated 380 crows (Engbring and Ramsey 1984) were present in northern Guam. This number was much lower than the estimate of 1,300 crows on Rota in 1982 (Engbring et al. 1986). By 1986, Michael (1987) reported that only 100 crows remained on Guam. By then, most of Guam's native forest birds had disappeared as a result of brown tree snake predation (Savidge 1987, Conry 1988, Engbring and Fritts 1988). In 1990, DAWR began annual crow surveys using tape-playback of crow calls to monitor their status. The initial survey found about 100 crows still present in northern Guam. Though crow numbers had decreased since 1981, distribution remained the same (DAWR 1990).

Efforts to reverse the decline of the Mariana crow began in 1986 with attempts to protect active nest sites from snake predation. Sheet metal sleeves and Tanglefoot®, an adhesive resin, were placed around trunks of active nest trees to act as a snake barrier and snake-trapping was begun. During the early 1990s, increased nest protection was achieved with the development of electrical barriers and effective snake trapping (DAWR 1991).

OBJECTIVES

To inventory Mariana crows and their nest sites in order to implement recovery efforts including predator control and other reproductive enhancement efforts (Beck and Savidge 1990).

PROCEDURES

1. Recorded-call playback surveys for Mariana crows were conducted in northern Guam during July (Figure 1). At each station, tape-recorded calls were played for 2.5 minutes. This was followed by a 2-minute silent period when the observer listened for crows. Numbers, distances, and plumage condition of the crows detected were recorded.

2. Areas in the northern Guam were searched during the breeding season (from October through May) for Mariana crows. Active nests were closely monitored and appropriate measures to protect them were taken. Locations of active nests were mapped.
3. Young, if found, were monitored.

RESULTS

Crow Surveys

Mariana crows were surveyed on 14 transects totaling 211 stations in eight regions of northern Guam in July (Figure 1). Birds were present on two transects, which is a slight increase from last year. A total of seven crows were recorded during the survey (Table 3), including six birds in the Conventional Weapons Storage Area (CWSA) and one bird in the C3 area of Northwest Field (Table 1).

The number of crows recorded during the FY97 survey is much lower than the actual number of birds still surviving. Transect 1 in the CWSA recorded six birds, but failed to detect three other birds known from the area. The nine known birds in the CWSA included one hand-reared Guam crow released in January 1997 and four Rota crows transferred from the National and Houston Zoos to Guam in February 1997, which were released in April and June. Unfortunately, the hand-reared Guam crow was found dead in August 1997, reducing the number of crows in the CWSA to 8 birds.

Table 1. Summary of results from playback of tape-recorded Mariana crow calls conducted in July 1997. Transect locations are shown in Figure 1.

Transect	No. of stations	No. of crows	No. of stations with crows	Known no. of crows missed in survey
1	50	6	4	3
2	36	0	0	1
3	12	0	0	0
4	10	0	0	0
5	8	0	0	0
6	11	0	0	0
7	10	0	0	3
8	23	0	0	0
9	8	0	0	1
10	9	0	0	0
11	7	0	0	0
12	8	0	0	0
13	8	1	1	0
14	9	0	0	2
Total	211	7	5	10

July 97 crow population estimate = 7 + 10 = 17 birds

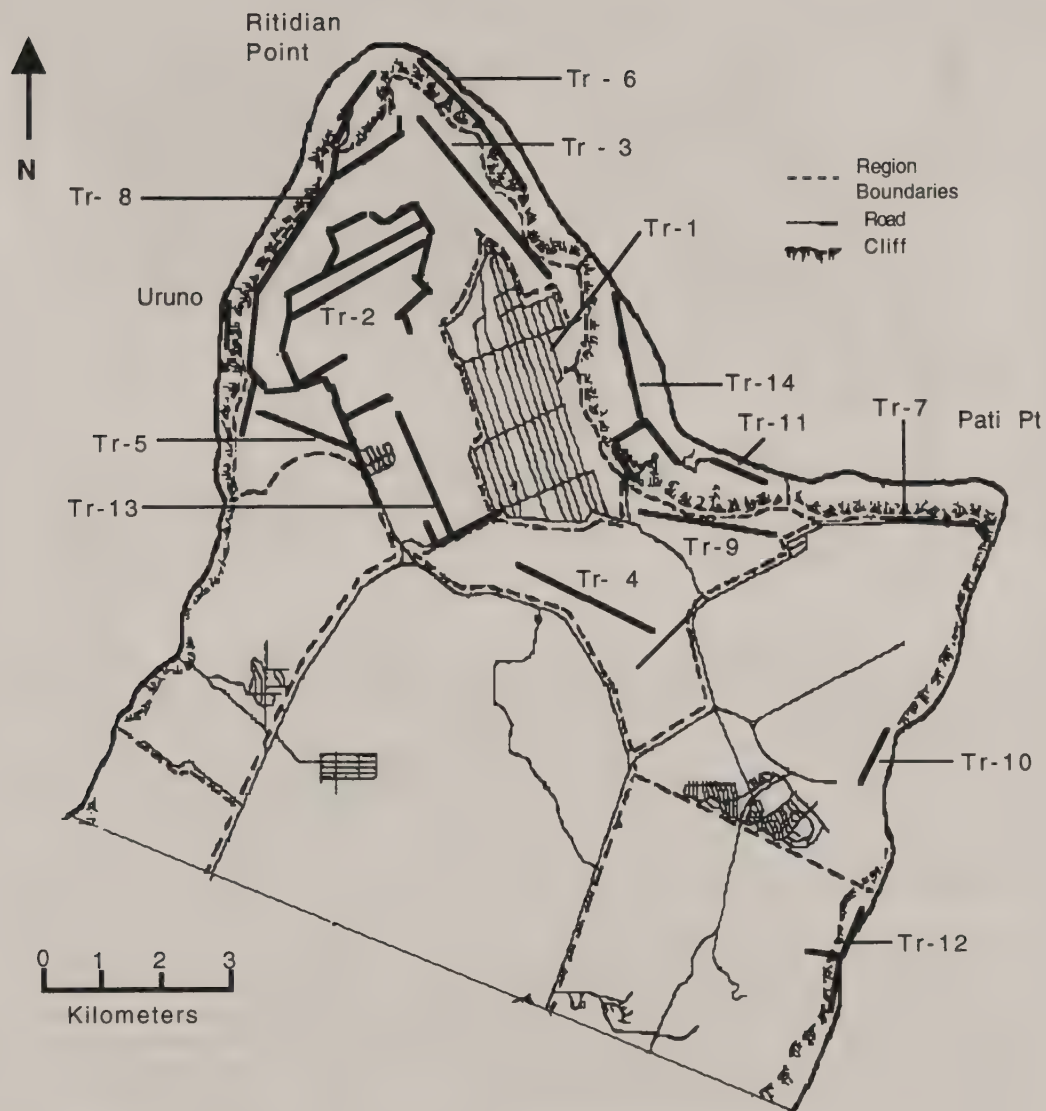


Figure 1. Locations of Mariana crow survey transects on Guam.

In the Pati Point area, the CWSA pair and two singletons (Pipeline and Pati Point singletons) were observed during the survey (Figure 2). No birds were recorded on Transect 7. The Tarague region still harbors the Tarague pair, which was not recorded during the survey. This pair is known to fly fairly long distances between the CWSA and Tarague areas (Figure 2).

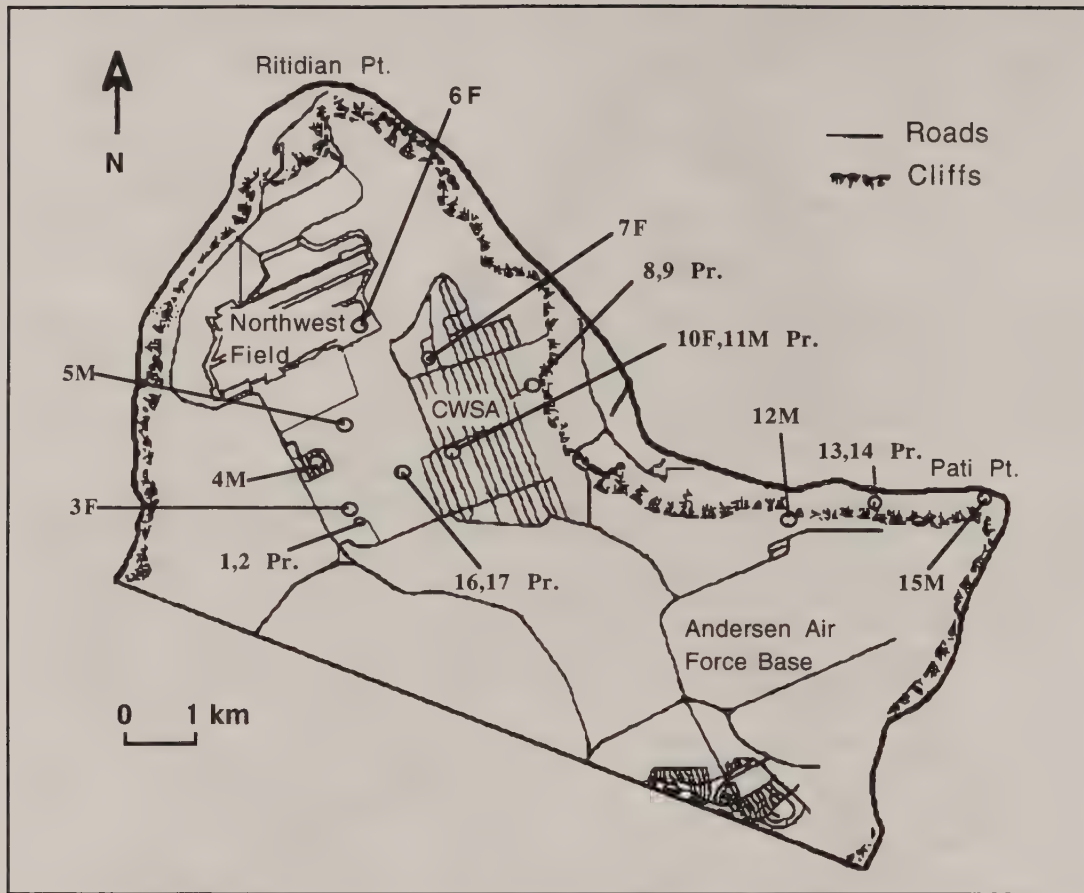


Figure 2. Locations of known crows (in circles) in the Northwest Field, Conventional Weapons Storage Area (CWSA), and Pati Point areas as of July 1997. Each location is noted as a male (M), female (F), or pair (Pr.). Pair 1, 2 was composed of a hand-reared Guam crow ("Joga") and a female zoo bird. Joga was found dead in August 1997. The other released hand-reared Guam crow is 6F ("Nunu"), whose status is unknown. The four surviving released zoo crows include 2F ("Fadang"), 4M ("Ahgao"), 7F ("Pengua"), and 10F ("Faia"). Two other released zoo crows, a male and female, died prior to the survey.

Crows were not recorded in Northwest Field, but a hand-reared female Guam crow was released in the area in February 1997. Unfortunately, her radio transmitter failed making observations difficult and her status is unknown.

When the number of birds recorded during the survey is added to the number of missed birds (excluding repeats), minus the loss of the released hand-reared bird, an overall population estimate of 16 crows is obtained for Guam. This estimate is a 14% increase over last year's count (DAWR 1996), but includes the addition of released birds. The number of crows on Guam continues to be very low (Figure 3) because of lack of reproduction. The population will not survive much longer without the translocation of additional birds from Rota.

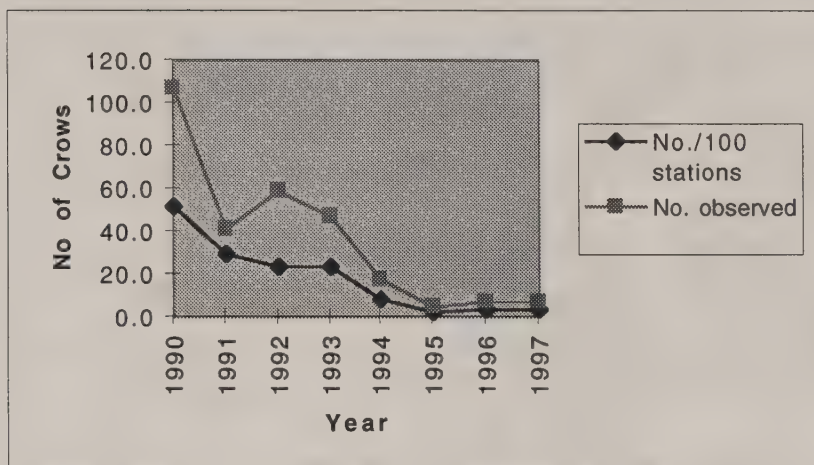


Figure 3. Yearly results of Mariana crow playback surveys conducted on Guam since 1990. The number of birds estimated in 1997 includes four Rota crows released in the wild this year.

Active nests

Nesting activity during the 1996-1997 breeding season was very poor, with only one nest found despite intensive searches in areas with crows (Figure 4). This single nest built by the Tarague Jeep Road pair and was found on January 21 in a *Ficus* tree in the CWSA. No eggs were laid after snake-proofing occurred, thus, a dummy egg was placed in the nest. Observations revealed nest attendance to be normal (95-100%) for 21 days, which is the normal length of the incubation period, before the nest was abandoned. This observation was significant in that this had been the only known pair to build nests in the past few breeding seasons. Potentially, crow pairs such as this one, which are believed to be unable to lay eggs, can be used in the future as surrogates for incubating eggs or raising chicks.

A second pair, the 11B6 pair, was observed on several occasions taking sticks to an *Elaeocarpus* tree, but this activity did not result in the construction of a nest. Their efforts ended with the sticks falling to the ground or being blown off the branches, followed by the pair flying away. During the 1995-1996 breeding season, this pair nested and laid a single-egg clutch (DAWR 1996). Their behavior this season is probably indicative of their old age. The female was brought into captivity in 1989, rehabilitated, and released back into the wild in October 1994. She is now at least 10 years old and probably beyond reproductive age. This was the last known egg-laying pair left on Guam.

Of the six Rota crows and two Guam birds that were released in the wild on Guam in the early part of 1997, four Rota crows (three females and a male) are still alive and one Guam crow's status is unknown. Of the released birds, one had paired with a Guam bird by September 30, but the pair did not breed. A second Rota female lost its Guam mate in August, but did not remate with any of the remaining crows.

The very low reproductive success documented over the previous few breeding seasons was probably a result of senescence (DAWR 1995-1996). The lack of nesting activity this season is additional evidence supporting the senescence hypothesis. Though improved techniques (e.g., improved trapping and electrical barriers) have been developed to prevent snake predation at nests, low reproductive success related to the elderly age of the Guam birds can only be mitigated by releasing younger crows into the population.

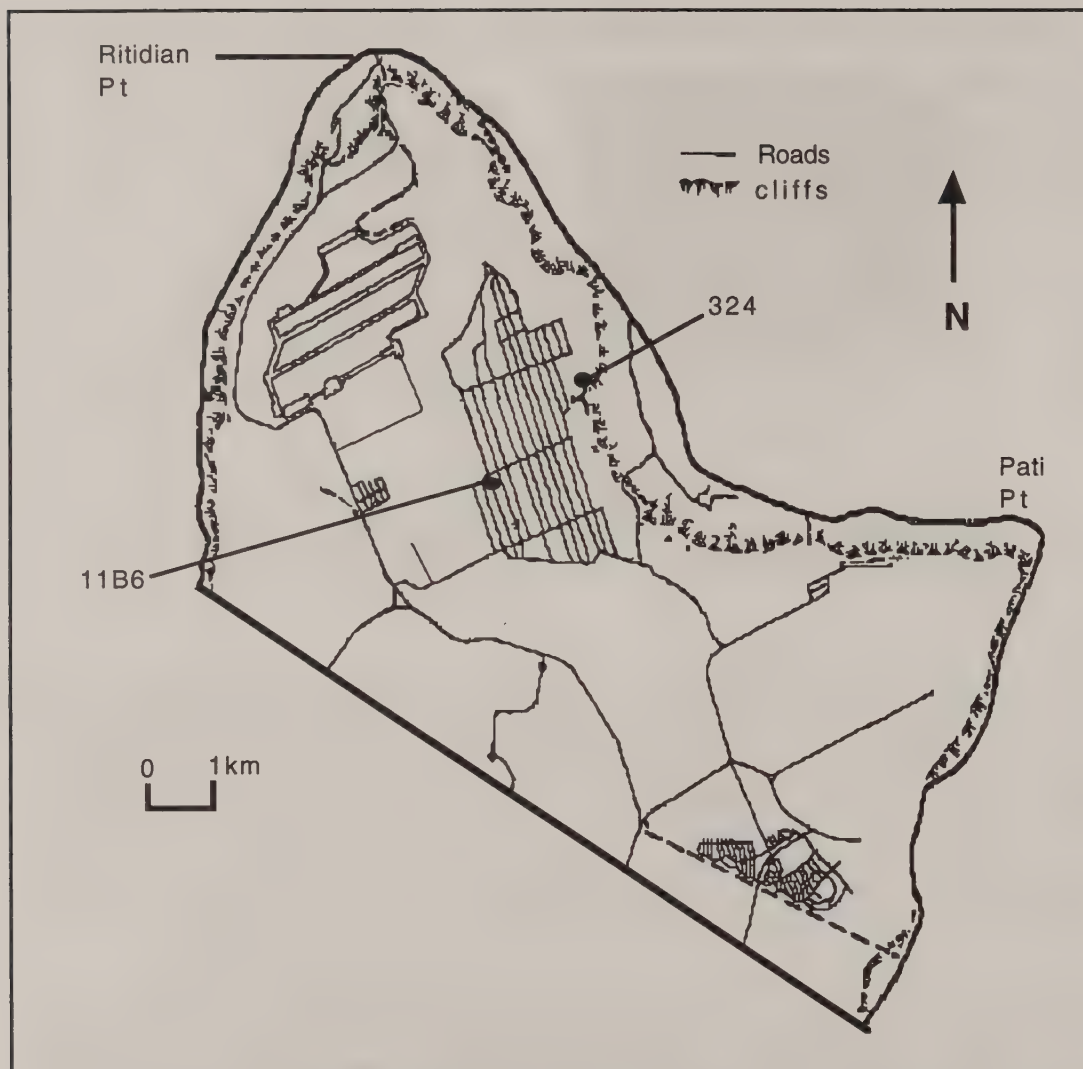


Figure 4. Location of the only nest (#324) produced during the 1996-1997 crow breeding season, which was made by the Tarague Jeep Road pair. The 11B6 pair made several feeble attempts to build a nest, but none were ever completed.

RECOMMENDATIONS

1. Continue crow surveys.
2. Continue searches for active crow nests and take appropriate measures to protect nests from snake predation.
3. Collect pertinent information where crow nests are found.

PROGRAM COST

The estimated cost of the Mariana crow project under W-1R-5 is \$80,000.

LITERATURE CITED

- Beck, R. E. B., Jr., and J. A. Savidge. 1990. Native forest birds of Guam and Rota of the Commonwealth of the Northern Mariana Islands recovery plan. US Fish and Wildlife Service, Portland, Oregon. 86 pp.
- Conry, P. J. 1988. High nest predation by brown tree snakes on Guam. *Condor* 90:478-482.
- Division of Aquatic and Wildlife Resources (DAWR). 1990-1996. Job Progress Reports - Federal Aid to Fish and Wildlife Restoration. Guam Dept. Agric., Mangilao.
- Engbring, J. and F. L. Ramsey. 1984. Distribution and abundance of the forest birds of Guam: results of a 1981 survey. U.S. Fish and Wildlife Service, Dep. of Interior. FWS/OBS-84/20. 54p.
- Engbring, J., F. L. Ramsey, and V. J. Wildman. 1986. Micronesian forest birds survey, 1982: Saipan, Tinian, Agiguan, and Rota. U.S. Fish and Wildlife Service, Honolulu.
- Engbring, J. and T. H. Fritts. 1988. Demise of an insular avifauna: the brown tree snake on Guam. *Transactions of the Western Section of the Wildlife Society* 24:31-37.
- Michael, G. 1987. Notes on the breeding biology and ecology of the Mariana or Guam Crow. *Avicult. Mag.* 93:73-82.
- Savidge, J. A. 1987. Extinction of an island forest avifauna by an introduced snake. *Ecology* 68:660-668.

Report was prepared by: Celestino F. Aguon

JOB PROGRESS REPORT RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: W-1R-5
SUB-PROJECT NO.: W-5
STUDY NO.: 1
JOB NO.: 1

JOB TITLE: Current Status, Distribution, and Natural History of Mariana Fruit Bats (1460)

PERIOD COVERED: October 1, 1996 to September 30, 1997

SUMMARY

During FY97, Guam's fruit bat population ranged in size from an estimated high of 425-470 animals in March to a low of 210-245 animals in September. However, numbers were low (< 200 animals) for much of the year at the island's only bat colony, with a September count of 125 animals being the lowest count since 1979. The colony continued to roost at a single site on Pati Point for the third consecutive year. The U.S. Fish and Wildlife Service (USFWS) announced its intention to down-list the Guam fruit bat population from Endangered to Threatened under the U.S. Endangered Species Act if bat populations in the Commonwealth of the Northern Mariana Islands (CNMI) are designated as Threatened.

BACKGROUND

The Mariana fruit bat (*Pteropus mariannus mariannus*) has been studied by the Division of Aquatic and Wildlife Resources (DAWR) since 1962 (DAWR 1964-1996). Considered a delicacy by Chamorro residents, bat abundance declined during the 1960s and 1970s until only a few solitary animals remained (Perez 1972, Wheeler and Aguon 1978, Wiles 1987a). A second species, the little Mariana fruit bat (*P. tokudae*), also occurred on the island, but is now extinct (Wiles 1987a). Reasons for the declines were primarily overhunting and some loss of habitat (Wheeler 1979). Both *Pteropus* occur on the US and Guam Endangered Species Lists. The island's population of Mariana fruit bats grew to an estimated 850-1,000 animals in the early 1980s, probably from immigration of bats from Rota (Wiles 1987a, Wiles and Glass 1990). However, numbers have gradually declined since 1983 because of continued illegal hunting and suspected predation by brown tree snakes (*Boiga irregularis*) (Wiles 1987a, 1987b, Wiles et al 1995). During FY96, Guam's fruit bat population ranged in size from an estimated low of 230-265 animals to a high of 370-410 animals (DAWR 1996).

OBJECTIVES

To continue status surveys and natural history studies and to provide for continued protection of habitat as recommended in the Mariana Fruit Bat Recovery Plan (Wiles 1990).

PROCEDURES

1. Survey fruit bat distribution and numbers in Guam and the CNMI.

- a. Conduct annual surveys of fruit bats along Guam's northern cliffline with periodic surveys made elsewhere on the island. The emphasis of surveys should be to search for solitary bats and additional bat colonies.
 - b. Conduct monthly censuses at known bat colonies on Guam.
 - c. Assist the CNMI Division of Fish and Wildlife with surveys of fruit bats on other islands as needed.
2. Record information on the behavior and reproduction of fruit bats in colonies.
 3. Determine habitat use of fruit bats. Visit abandoned roosts and record information about terrain and the size and abundance of vegetation present.
 4. Monitor fruit bat imports to Guam from other Pacific islands.
 5. Investigate illegal hunting of fruit bats on Guam. Visit abandoned roosting sites of colonies to determine illegal hunting effort. Assist conservation officers with investigations of bat poaching.

RESULTS

Locations of Bat Colonies on Guam

The island's only known fruit bat colony continued to occupy Roost 1 on Pati Point at Andersen Air Force Base (AAFB) throughout FY97 (Tables 1 and 2). The colony has used this location since July 1994. It has been a preferred roosting site for many years (DAWR 1987-1996).

Table 1. Approximate dates of use of the roost used by the only known colony of Mariana fruit bats on Guam in FY97.

Roost Number	Roost Location	Approximate periods of use by bats
1	North Pati Point	2 July 1994 - present

Table 2. Counts of Mariana fruit bats at roosts on Andersen AFB, Guam in FY97.

	Roost Number									
Date	1	14	15	16	17	18	19	20	21	Total
8 Oct 1996	168	-	-	-	-	-	-	-	-	168
28 Oct	165	0	0	0	-	0	0	0	0	165
11 Dec	171	-	-	-	-	-	-	-	-	171
2 Jan 1997	192	-	-	-	-	-	-	-	-	192
30 Jan	216	-	-	-	-	-	-	-	-	216
4 Mar	322	-	-	-	-	-	-	-	-	322
27 Mar	257	0	0	0	-	0	0	0	0	257
28 Apr	135	0	0	0	0	0	0	0	0	135
24 June	*	-	-	-	-	-	-	-	-	*
31 July	151	-	-	-	-	-	-	-	-	151
8 Sept	125	-	-	-	-	-	-	-	-	125

- = site was not checked for bats; * = colony was present, but complete count was not made.

Surveys of Fruit Bats on Guam

Counts at Roost 1 were relatively low throughout the year. Numbers increased dramatically from 171 fruit bats in mid-December to a peak of 322 bats in early March, then rapidly declined to 135 bats in late April (Table 2). Eventually, a low count of 125 bats was obtained in September. The latter count represents the smallest number of bats recorded in colonies on Guam since 1979 (DAWR 1979-1996). The overall pattern in animal numbers at the colony generally follows a trend observed in recent years of larger counts during the winter months and reduced counts from May-September (DAWR 1994). Data analyses indicate that bat numbers on Guam and Rota fluctuate inversely with one another and are highly suggestive of seasonal inter-island movements (Wiles et al., in prep.).

Estimates of fruit bat numbers at the main colony on Pati Point can be made using the high and low roost counts for the year. Because some individuals were probably hidden by thick foliage during counts, the total number of adults in the roost was likely to be 5-10% higher than the actual number recorded. Assuming that about half the colony were harem females and that 10% of these had unweaned young (DAWR 1994), then the roost held an estimated high of 338-354 adults and 17 juveniles, or a total of 355-371 bats in early March, and a low of 131-138 adults and 7 juveniles, or a total of 138-145 bats in September.

Regular fruit bat sightings were made along the cliffs at Ritidian Point by staff of the Guam National Wildlife Refuge throughout the year (M. Ritter and K. Allen, unpubl. data). Observations peaked from mid-June through July and again during September, when 2-3 individuals were seen almost daily. Copulations were regularly seen or heard, but there was no evidence of a small colony residing in the area. Bat feeding sign on *Artocarpus mariannensis* was found in early July.

Incidental sightings of single fruit bats or pairs of bats were made elsewhere on the island during the year, as follows: daytime sightings -- Conventional Weapons Storage Area on AAFB (2 sightings), Fena Lake (1); nighttime sightings -- west end of the main airfield at AAFB (2), forest northwest of the main airfield on AAFB (1), Tarague basin (1), Route 16 near Mt. Barrigada (1, this bat flew from Tiyan towards Mt. Barrigada at dawn), the Asalanso region of Malojloj (1), the High Road (1) and the 15 Group (1) on U.S. Naval Ordnance Annex (formerly Naval Magazine), and Fena Lake (1).

Excluding bats residing in the colony at Pati Point, an estimated 50-75 fruit bats are still believed to live solitarily or in small groups in northern Guam, primarily along the cliffline extending from Bijia Point to Iates Point. An additional, 20-25 animals probably inhabit the Ordnance Annex and other forested areas in southern and central Guam. Based on these figures, Guam's island-wide population of fruit bats varied from an estimated high of 425-470 animals in March to a low of 210-245 animals in September.

A summary of fruit bat sightings on Ordnance Annex from 1985-1996 appeared in Morton (1996).

David Woodside, a former biologist with the state of Hawaii and the USFWS, visited Guam in November and recalled some interesting historical information about fruit bats in the southern part of the island, based on observations he made during his 6-month temporary work assignment in 1957. He remembered sighting two bat colonies on Ordnance Magazine during a helicopter survey of the base. This record is significant because of the few previous reports of bat colonies documented for southern Guam.

Surveys of Fruit Bats on Other Islands

The DAWR did not assist in any bat surveys in the CNMI during FY97.

Illegal Hunting and Importations

Poaching has long been a major cause of mortality of *P. mariannus* in the southern Mariana Islands (Wiles 1987a, Wiles et al. 1989, Stinson et al. 1992). Poaching still occurs commonly on Rota and other islands in the Marianas (E. Taisacan, pers. comm., 1997). No reports of illegal hunting were recorded on Guam during the year.

Several illegal shipments of bats were confiscated by customs authorities on Guam and in the CNMI during the year (K. Garlick, pers. comm.). Confiscations made on Guam totaled: 26 bats from Palau in shipments of 1, 7, 9, and 9 bats; 5 bats from Yap (1 shipment); 1 bat from Saipan; and 1 bat from Rota. Confiscations on Saipan were as follows: 7 bats from Yap (1 shipment) and 4 bats from Palau (1 shipment).

The DAWR received one credible report of several bats being eaten at a party on Guam during the year. It was unknown whether the bats had been illegally killed on Guam or smuggled into the island.

Of historic interest, David Woodside stated that occasional shipments of fruit bats from Saipan and Rota were already entering Guam by 1957. This predates other known records of bat importations to Guam by 6-10 years.

Proposed Downlisting of the Mariana Fruit Bat Population on Guam

During FY97, the USFWS prepared documentation to designate *P. mariannus* throughout the CNMI as Threatened under the U.S. Endangered Species Act. Because the Guam population was previously listed as Endangered in 1984, this will result in federal protection for the species throughout the island chain. Based on evidence of inter-island movements, the USFWS believes that the archipelago's fruit bats constitute a single population. Because USFWS policy does not allow for different listing statuses within a population, the agency informed the DAWR in September of its intention to downlist bats on Guam to Threatened to coincide with their proposed legal status in the CNMI. This action will presumably occur when listing of the CNMI bats receives final approval.

Emballonura semicaudata

Dr. David Steadman of the Florida Museum of Natural History and Dr. Greg Pregill of the University of San Diego visited Guam in January to make preliminary site inspections for future archaeological digs of animal bones. During their investigation, they located the bones of *E. semicaudata* at several caves where this species had not been previously recorded, including the former Tarague swiftlet cave in the Tarague basin, a cliffside cave located 10-15 m above the beach level at Mergagan Point, and Mahlac Cave on Ordinance Annex.

RECOMMENDATIONS

1. Survey bat numbers and distribution along Guam's entire northern cliffline once or twice annually. Searches for additional colonies may be productive because continued poaching at bat roosts on Rota can cause large numbers of bats to move to Guam (Wiles and Glass 1990).

2. Continue observations at Guam's bat colonies. Information on reproductive biology, behavior, and social organization will be used to supplement data already gathered.
3. Summarize data previously collected and write reports on the diet, reproduction, and amount of snake predation on fruit bats.
4. Conduct a study of the vegetation, terrain, and proximity to development of known roosting sites to determine what site characteristics are important in the selection of roosting sites by fruit bat colonies.
5. Known bat roosting and foraging areas should be patrolled regularly by DAWR conservation officers.
6. Continue to assist the CNMI as needed with island censuses and other biological studies. Studies conducted on Rota would be most valuable for understanding the aspects of Guam's fruit bat population.
7. Continue to monitor illegal fruit bat imports entering Guam.

PROGRAM COST

The estimated cost of the fruit bat project under W-1R-5 is \$30,000.

LITERATURE CITED

- Division of Aquatic and Wildlife Resources. 1964-1996. Job Progress Reports - Federal Aid to Fish and Wildlife Restoration, Guam. Guam Dept. Agric., Mangilao, Guam.
- Morton, J.M. 1996. Mariana fruit bat surveys on the Ordnance Annex. pp. 99-108 *in* Faunal Survey for the Ordnance Annex, Naval Activities, Guam. U.S. Fish Wildl. Serv., Honolulu.
- Perez, G.S.A. 1972. Observations on Guam bats. *Micronesica* 8:141-149.
- Stinson, D.W., P.O. Glass, and E.M. Taisacan. 1992. Declines and trade in fruit bats on Saipan, Tinian, Aguijan and Rota. pp. 61-67 *in* Wilson, D.E. and G.L. Graham (eds.). Pacific island flying foxes: proceedings of an international conservation conference. U.S. Fish Wildl. Serv. Biol. Rep. 90(23). 176 pp.
- Wheeler, M.E. 1979. The Marianas fruit bat: management history, current status and future plans. *Calif.-Nev. Wildl. Trans.* 10:149-165.
- Wheeler, M.E. and C.F. Aguon. 1978. The current status and distribution of the Marianas fruit bat on Guam. *Aquatic Wildl. Resour. Div., Tech. Rep. No. 1.* 29 pp.
- Wiles, G.J. 1987a. The status of fruit bats on Guam. *Pac. Sci.* 41:148-157.
- Wiles, G.J. 1987b. Current research and future management of Marianas fruit bats (Chiroptera, Pteropodidae) on Guam. *Aust. Mammal.* 10:93-95.
- Wiles, G.J. 1990. Guam Mariana fruit bat and little Mariana fruit bat recovery plan. U.S. Fish Wildl. Serv., Portland, Oregon. 57 pp.

- Wiles, G.J. and P.O. Glass. 1990. Inter-island movements of fruit bats (*Pteropus mariannus*) in the Mariana Islands. Atoll Res. Bull. 343:1-6.
- Wiles, G.J., C.F. Aguon, G.W. Davis, and D.J. Grout. 1995. The status and distribution of endangered animals and plants in northern Guam. Micronesica 28:31-49.
- Wiles, G.J., T.O. Lemke, and N.H. Payne. 1989. Population estimates of fruit bats (*Pteropus mariannus*) in the Mariana Islands. Conserv. Biol. 3:66-76.

Report was prepared by: Gary J. Wiles

**JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT**

STATE: Territory of Guam

PROJECT NO.: W-1R-5
SUB-PROJECT NO.: W-5
STUDY NO.: 1
JOB NO.: 4

JOB TITLE: Roost Site Characteristics of Mariana Fruit Bats

PERIOD COVERED: October 1, 1996 to September 30, 1997

SUMMARY

No significant effort was expended on this job during this segment.

PROGRAM COST

The estimated cost of the fruit bat project under W-1R-5 is zero.

Report was prepared by: Gary J. Wiles

PROGRESS REPORT COORDINATION PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: W-1R-5
SUB-PROJECT NO.: W-6
STUDY.: 1
JOB NO.: 1

JOB TITLE: Technical Guidance to Projects Affecting Guam's Wildlife Resources
(1210)

PERIOD COVERED: October 1, 1996 to September 30, 1997

BACKGROUND

The Wildlife Section professional staff of the Division of Aquatic and Wildlife Resources (DAWR) devoted a significant percentage of their time and effort to technical assistance. The pace of development on the island is requiring increasing amounts of time from the Section's staff to fulfill its statutory responsibility to review and comment on development plans, rezoning applications, and various permit applications most of which are local Government of Guam or private sector. In addition, the Section also provides comment and review of numerous activities and proposals from the military bases on Guam that may affect Guam's endangered species and wildlife resources and their habitat. Often this includes commenting on U.S. Fish and Wildlife Service (USFWS) Section 7 consultations concerning impacts of military projects on endangered species. Because of the size and complexity of some of these developments, the Section's review responsibility will require a continuing commitment that often extends beyond project completion.

The professional staff in the Wildlife Section provide technical support to the Division's technical assistance program staff and often take the lead in the review of projects involving their particular expertise, such as those that may have endangered species impacts or those involving wetlands. This effort is extremely important for the management and conservation of Guam's natural resources.

OBJECTIVES

1. To minimize adverse environmental impacts resulting from the construction of recreational, commercial, residential, industrial, military, or public utility facilities.
2. Provide technical assistance to farmers and other landowners, including private, territorial, and federal, for controlling wildlife damage to crops, native habitat, and other property.
3. Provide technical assistance to military and civil agencies relative to the management and protection of Guam's wildlife resources.
4. Provide data and analyses to assist the Department in promulgating hunting regulations for the Territory to provide recreational opportunities for the public, control damage to native habitat, and other needs as they arise.

FINDINGS

Wildlife Section staff have been actively involved in the technical guidance function during this segment. Numerous development plans, impact statements, and permit applications, which were submitted to the Division for review required the Wildlife Section's assistance. Field investigations and meetings with responsible agencies have been conducted in many cases as a part of the review process.

Various Section staff members actively serve as members of the following groups:

1. Region IX Regional Response Team - Oceania
2. Fish and Wildlife Natural Resource Committee- Andersen Air Force Base
3. Pacific Islands Recovery Team for Birds and Bats, USFWS
4. Captive Breeding Working Group, USFWS
5. Area Committee for Oil Spills

Members of the Wildlife Section have attended numerous meetings and hearings pertaining to the protection of Guam's natural resources and have actively consulted with various civil and military agencies on environmental matters. Section staff maintain close liaison with the Department of Parks and Recreation, Guam Bureau of Planning, Guam Environmental Protection Agency, University of Guam, U.S. Army Corps of Engineers (ACOE), USFWS, U.S. National Marine Fisheries Service, U.S. Navy, Coast Guard, and Air Force regarding matters of environmental concern. In addition, staff members actively consulted with numerous off-island visitors, representing various agencies and organizations, who visited during the segment.

Wildlife Section staff Biologist III Celestino Aguon was appointed a member of the USFWS Mariana Crow Recovery Team.

Considerable public contact was maintained by Section staff during the reporting segment. In addition to occasional interviews on radio, television, and in newspapers, staff members gave talks to a number of civic groups, sportsman clubs, and school and university classes.

Some more specific Technical Assistance activities of the Wildlife Section included:

1. The Division was represented on the Development Review Committee by its technical review staff, which met biweekly to review applications for rezoning, variances, and various types of development. The Division's input at this level is very important in ensuring that the protection of Guam's fish and wildlife resources be considered in land use planning. Wildlife professional staff provided significant technical input into this review process at various levels on numerous occasions.
2. The Division reviewed and commented on ACOE applications for wetland fill. Mitigation recommendations were often included in these comments. Comments and concerns were also provided to various local agencies. Wildlife staff provided significant input into the responses for these applications. Endangered species were of primary concern to the Section with Mariana common moorhens found in most wetlands on Guam.

3. The Section provided technical support to the Division's enforcement staff by identifying and evaluating wildlife, testifying at court hearings, and recommending disposition for confiscated wildlife.
4. Section staff provided technical assistance to the Department of Agriculture's Plant Protection Quarantine Division by identifying confiscated wildlife and wildlife products, holding wildlife in quarantine, and in general supporting their efforts at preventing illegal imports of wildlife to Guam.
5. The Division reviewed and commented on numerous Environmental Impact Statements/Assessments of proposed developments particularly when wildlife issues were present. These comments included recommendations for grading and clearing, erosion control, project design and orientation. These recommendations were made to reduce and/or eliminate impacts to the immediate and adjacent environments.
6. The Division's Wildlife Section provided comments at the request of the USFWS for numerous Section 7 Consultations under the Endangered Species Act, including the following:
 - a. Several construction projects at U.S. Naval Ordnance Annex Guam.
 - b. Numerous military training exercises at AAFB and Naval bases on Guam.
 - c. Several wetland related development activities for civilian and military projects.
7. The Section reviewed and commented on several legislative bills that would affect wildlife.
8. The Section responded to many requests for information on laws and regulations pertaining to fish, wildlife, endangered species, hunting and fishing, and importation of wildlife.
9. The Section responded to numerous public requests for information on native wildlife, particularly endangered species.
10. The Section answered numerous requests for information on hunting from both on and off-island individuals. Specific requests included information on hunting areas, hunter safety classes, firearm regulations, hunting seasons and limits, and laws and regulations.
11. Section staff provided technical assistance to numerous farmers and the Air Force and Navy regarding pig damage. Damage control permits requests were evaluated and issued when warranted.
12. Section staff reviewed wildlife-related manuscripts for professional journals. One of our staff is an editor for the University of Guam's journal *Micronesica* and in this capacity reviewed several articles for publication.
13. Section staff assisted in presented hunter safety briefings at Anderson Air Force Base and the Mangilao Community Center to provide pertinent information to hunters.
14. Section staff made numerous presentations on fish and wildlife resources at meetings of various organizations during the year.
15. Section staff prepared numerous press releases to keep the public informed of fish and wildlife issues including hunting and hunting seasons, brown tree snake issues,

fish and wildlife laws and regulations, endangered species, fish and wildlife importation, etc.

16. Technical assistance and logistic support was provided to various personnel from the USFWS, National Biological Survey, U.S. Department of Agriculture's Animal Damage Control working on the brown tree snake problem on Guam and in the mainland U.S.
17. The Section staff, at the request of numerous developers, met with them, their consultants and other government representatives to discuss proposed development projects and their potential impacts on endangered species, wetlands and native habitat as well as erosion, project design, etc.
18. Section staff provided technical assistance to USFWS and National Marine Fisheries Service law enforcement personnel on various matters including the importation of endangered species items.
19. Technical advice on wetland issues have been provided to the Development Review Section at the Guam Environmental Protection Agency.
20. Section staff participated in the Navy Installation Restoration Program by providing information to Navy consultants, accompanying them on several site visits, and attending public meetings.
21. Staff gave visiting lectures for various University of Guam biology classes on wildlife related topics.
22. Section staff assisted the USFWS with a weeklong field survey of the ungulates of Naval Ordnance Annex.
23. Section staff assisted Dr. David Steadman of the University of Florida Natural History Museum and Dr. Greg Pregill of the University of San Diego in searches for appropriate sites on Guam in which to conduct paleoarchaeological surveys.
24. Section staff were consulted by U.S. Department of Agriculture, Wildlife Services office for advice on control strategies pertaining to yellow bitterns at the Guam International Airport.
25. Section staff assisted the military in planning field training exercises at various military bases on Guam so that endangered species and their habitat and other wildlife resources would be minimally impacted. Military units involved included:
 - a. Guam National Guard
 - b. Various Air Force units
 - c. Air National Guard
 - d. University of Guam Army ROTC
 - e. Various DOD special operations units
 - f. U.S. Army Reserves

26. Section staff on numerous occasions met with representatives of the press to discuss wildlife issues the media was interested in. Contact was made with the following organizations:

- a. Pacific Daily News, Guam
- b. KUAM TV News, Guam
- c. Guam Cable TV News
- d. KGTF public radio, Guam
- e. K-57 radio news, Guam

PROGRAM COST

The estimated cost of the technical assistance project under W-1R-5 is \$60,000.

RECOMMENDATIONS

Continue technical assistance activities in support of the conservation of Guam's wildlife.

Report was prepared by: Robert Beck

JOB PROGRESS REPORT RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: E-1-12

STUDY NO.: 4

JOB NO.: 1

JOB TITLE: Captive Breeding Endangered Native Birds

PERIOD COVERED: October 1, 1996 to September 30, 1997

SUMMARY

The number of Guam rails, *Gallirallus owstoni*, at the Division of Aquatic and Wildlife Resources' (DAWR) captive breeding facility on Guam increased from 71 birds on October 1, 1996 to 85 birds on September 30, 1997. Nine breeding pairs produced 171 eggs, 51 (30%) of which hatched. Forty-one chicks lived for at least 30 days of age and were banded and added to the captive flock by September 30, 1997. Nine adult rails died. One rail that escaped in FY96 was recaptured. Nineteen birds were transferred to Rota and released into the wild. No Mariana crow, *Corvus kubaryi*, eggs were produced in the wild for artificial rearing in the DAWR's wildlife lab. As of September 30, 1997, there were 50 Micronesian kingfishers, *Halcyon c. cinnamomina*, in captivity at mainland U.S. zoos, including two viable offspring hatched in FY97.

BACKGROUND

The Guam Native Forest Bird Captive Breeding Program began in 1983 as a cooperative effort between the DAWR, member zoos of the American Zoo and Aquarium Association, (AZA) and the U.S. Fish and Wildlife Service (USFWS) (DAWR 1983, Derrickson 1986, Shelton 1986). Predation by the brown tree snake, *Boiga irregularis*, now believed to be the single most important factor in the recent drastic decline of Guam's native forest birds (Savidge 1986, 1987; Conry 1988), precipitated the need for a captive breeding program when by 1982 at least five species of Guam endemic species or subspecies were nearing extinction in the wild. Unfortunately, by 1984, attempts at captive breeding three of these species, the bridled white-eye, *Zosterops c. conspicillata*, rufous fantail, *Rhipidura rufifrons uraniae*, and the Guam flycatcher, *Miagra freycineti*, were abandoned due to their disappearance from the wild (DAWR 1984).

The Guam rail and Guam subspecies of the Micronesian kingfisher were successfully brought into captivity (DAWR 1983-1986), with the capture of 19 and 31 wild birds, respectively. Rails first bred at the DAWR's facility on Guam and later at the Conservation and Research Center (CRC) of the National Zoological Park during 1984.

Kingfishers were first bred in 1985 at three mainland U.S. zoos (Bronx Zoo, Philadelphia Zoo and the CRC). During FY88, the first studbook for the Micronesian kingfisher was published by the Philadelphia Zoo (Bahner 1989). The kingfisher has been designated as a Species Survival Program species by the AZA. Beth Bahner of the Philadelphia Zoo was designated by the AZA as studbook keeper. The kingfisher program has been relatively successful, as 17 of 29 founders produced descendants (the last previously underrepresented living founder sired offspring in 1994), and the population reached a peak of 62 individuals in August 1990. However, problems such as high chick mortality,

high young adult mortality, aggression, and infertility continue to limit population growth (Bahner 1993).

OBJECTIVES

1. Implement and manage captive breeding programs for the Guam rail and other endangered endemic birds by setting up facilities on Guam and at zoos on the mainland U.S. through the AZA.
2. Produce enough Guam rails for release and establishment of an experimental wild population on Rota, CNMI.
3. Enhance reproductive output of Mariana crows in the wild using avicultural support.
4. Become more administratively active in the management of captive Micronesian kingfishers.

PROCEDURES

1. Continue the routine maintenance and operation of a cooperative captive breeding program for the Guam rail and Micronesian kingfisher with the AZA and its member zoos.
2. Develop techniques for the successful release of captive-reared birds in the wild once the factors responsible for their decline have been controlled.
3. Continue to consult with recognized authorities regarding captive breeding methodology, facility designs, and captive population management techniques.
4. Consult and coordinate with USFWS, U.S. Department of Agriculture, and other government agencies with jurisdiction over the interstate movement and captive maintenance of wildlife. Acquire all necessary local and federal permits.
5. Breed rails in sufficient numbers to support the continuing introduction of the Guam rail to Rota, CNMI.
6. Maintain regular contact with the Micronesian kingfisher studbook keeper, and make recommendations to the SSP.
7. Coordinate efforts between field and laboratory for manipulating nests, eggs, and chicks of Mariana crows in the wild.

RESULTS

The number of Guam rails at the DAWR's captive breeding facility on Guam increased from 71 to 85 during FY97. Forty-one chicks were added to the captive flock, and 19 adults were transferred and released on Rota. Nine adult rails died at the DAWR captive breeding facility. One older rail died as a result of stress and handling after Typhoon Dale in November 1996. Two females died of aggression from cage mates. One rail died from apparent rat predation (a rat probably entered the cage through a hole in the wire mesh). One bird died of acute liver toxicity. Two young rails died of coccidiosis. Two young rails were euthanized after testing positive for coccidia. One adult rail that escaped from a breeding pen in FY96 was recaptured 7 months later after it was determined that the bird was living among the vegetation along the fence line of the rail yard.

Coccidia, a naturally occurring intestinal parasite, was first discovered in Guam rails in February 1997 after two chicks died. Screening of all rails failed to detect coccidia in any bird except those from one breeding pair. Two older chicks tested positive for coccidia and were euthanized to prevent the spread of the parasite to other rails in the captive population. The remaining birds in the family line (n=9) were treated for 3 weeks with a coccidiostat, then immediately transferred and released on Rota. It was the medical opinion of several consulting veterinarians, including Dr. Don Nichols, the Guam rail SSP pathologist, that coccidia is a naturally occurring parasite that poses no disease threat to adult rails, and that the high host specificity of the organism poses no threat to any other species of animals. Coccidiosis is only problematic for birds confined in small spaces, and young chicks (hatchlings) are most vulnerable to systemic infections. Adult rails build a natural immunity and the parasite poses no disease threat to birds in the wild.

The reasons for the low level of productivity (30% hatch rate) experienced in FY97 are undetermined. As many as eight eggs and one chick were lost due to Typhoon Isa in April 1997. Some breeding pairs that were productive in calendar year 1996 fell off in productivity in calendar year 1997. In an attempt to curb nest failure, 13 eggs were removed from nests for artificial incubation and four young rails were hand-reared.

Two staff members left the Guam rail program in December 1996 and May 1997. Five new staff members joined the program, resulting in a complete staff turnover for the rail breeding program in FY97. Suzanne Medina was hired as a Biologist II in July 1997. Ms. Medina has extensive experience in aviculture. Dante Buensuceso and Jeffrey Quitugua were hired as Technician I's and Chris Jones and Romano Santos were hired as Biological Aides. Dr. Scott Derrickson, Curator of Birds, CRC, continued as coordinator for AZA's Guam rail program. No rails were bred in captivity in mainland zoos during FY97.

Reproduction of Mariana crows in the wild diminished to zero in FY97. No eggs were produced by any crows in the wild or captivity.

Micronesian kingfishers continued to be bred at eight mainland U.S. zoos (reduced from 13 institutions as a result of the 1995 Action Plan). The Micronesian kingfisher population at mainland U.S. zoos declined from 53 by September 30, 1996, to 50 by September 30, 1997. Adult mortality continued to offset reproduction in FY97. Only two viable offspring were produced.

Dr. Ilse Silva-Krott and colleagues including Dr. Randy Junge, the Micronesian kingfisher SSP veterinarian, received a grant from Disney (via the AZA) to conduct a study of occurrence of *Mycobacterium avium*, the agent that causes avian tuberculosis, on Guam. Pooled samples from birds (primarily poultry) in each of 21 villages on Guam were analyzed, and two tested positive for *Mycobacterium avium*. This study quelled concerns regarding the risk of introducing a new disease to Guam (avian tuberculosis) if Micronesian kingfishers are repatriated. A manuscript was submitted for publication to *Pacific Conservation Biology*.

RECOMMENDATIONS

1. Continue the routine maintenance and operation of a cooperative captive breeding program for the Guam rail and Micronesian kingfisher with the AZA and its member zoos.
2. Continue to consult with recognized authorities regarding captive breeding methodology, facility design, and captive population management techniques.

3. Consult and coordinate with USFWS, U.S. Department of Agriculture, and other government agencies with jurisdiction over the interstate movement and captive maintenance of wildlife. Acquire all necessary local and federal permits for shipment of rails between Guam and mainland U.S. zoos.
4. Breed rails in sufficient numbers to support the continuing introduction of the Guam Rail to Rota, Commonwealth of the Northern Mariana Islands.
5. Coordinate with Dr. Scott Derrickson of the CRC the transfer of Guam rails produced in zoos to Guam for the purposes of captive breeding at the Guam facility or for release on Rota.
6. Continue avicultural intervention of Mariana crows and support efforts of DAWR to increase production of crows in the wild through efforts to snake-proof crow nest sites.
7. Initiate plans for the repatriation of Micronesian kingfishers to the captive breeding facility on Guam.

PROGRAM COST: The estimated cost of the project is \$158,617.

LITERATURE CITED

- Bahner, E.L. 1989. 1988 North American Regional Studbook for the Micronesian Kingfisher, *Halcyon c. cinnamomina*. Zoological Society of Philadelphia, Philadelphia, Pennsylvania.
- Bahner, E.L. 1993. SSP Master Plan (1993) & 1992 North American Regional Studbook for the Micronesian Kingfisher, *Halcyon c. cinnamomina*. Zoological Society of Philadelphia, Philadelphia, Pennsylvania.
- Conry, P.J. 1988. High nest predation by the brown tree snake on Guam. *Condor* 90:478-482.
- Derrickson, S.R. 1986. Captive propagation of the Guam Rail. *The Philadelphia Zoo Review* 2:19-23.
- Division of Aquatic & Wildlife Resources (DAWR). 1961-1986. Job Progress Reports - Federal Aid to Fish and Wildlife Restoration. Department of Agriculture, Guam.
- Kuehler, C., M. Kuhn, B. McIlraith, and G. Campbell. 1994. Artificial incubation and hand-rearing of 'Alala (*Corvus hawaiiensis*) eggs removed from the wild. *Zoo Biology* 13:257-266.
- Savidge, J.A. 1986. The role of disease and predation in the decline of Guam's avifauna. Ph.D. Thesis. University of Illinois, Urbana-Champaign.
- Savidge, J.A. 1987. Extinction of an island avifauna by an introduced snake. *Ecology* 68:660-688.
- Shelton, L.C. 1986. Captive propagation of the Micronesian Kingfisher. *Philadelphia Zoo Review* 2: 28-31.

Report was prepared by: M. Kelly Brock

JOB PROGRESS REPORT RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: E-1-12

STUDY NO.: 4

JOB NO.: 2

JOB TITLE: Development of an Experimental Population of Guam rails in the Commonwealth of the Northern Mariana Islands (1480, 1311)

PERIOD COVERED: October 1, 1996 to September 30, 1997

SUMMARY

Nineteen Guam rails (*Gallirallus owstoni*) were released at the Sagua'gagha area of Rota in August and September 1997. Twelve of the rails (5 males, 7 females) were released into a 1.6 ha enclosure in the forest, while 2 breeding pairs were released in separate 25 m² holding pens. The remaining 3 birds (3 males) were released outside the enclosure within 400 m. Extensive efforts were made to remove predators from the release area. Mortality was 32% as six rails were confirmed dead. Sixty-three percent (n=12) of the rails survived to the end of the monitoring period. Forty-two percent (n=5) of the birds escaped the enclosures during the monitoring period. One radio-marked bird either escaped and dispersed from the release area or its transmitter failed. There was a problem with some of the transmitters exhibiting frequency drift. Rails that escaped from the enclosure or were released outside moved a mean distance of 756 m away from the release site, with the longest documented distance being 2.9 km. Rails (n=5) remained in the enclosures a mean of 10 days (range = 3-18 days) before escaping. Although work continued on the rail project beyond the end of the fiscal year, the 10-year cooperative agreement between Guam, U.S. Fish and Wildlife Service (USFWS) and Commonwealth of the Northern Mariana Islands (CNMI) for the introduction program expired September 30, 1997.

BACKGROUND

Census data collected between 1960 and the early 1980s documented the reduction in range and numbers of the Guam rail (Witterman et al. 1990). In 1984, only about 20 rails were known to remain in the wild and the species was added on the U.S. Endangered Species List. In 1982, the DAWR decided to develop a captive breeding program for the Guam rail and by 1986, all known remaining rails were collected (n = 21). The extirpation of the Guam rail from the wild was due primarily to predation pressure from the introduced brown tree snake (*Boiga irregularis*). The captive propagation program was organized under the auspices of the American Zoo and Aquarium Association (AZA) and presently includes the cooperation of 18 mainland zoos. The rails demonstrated an immediate propensity for breeding in captivity and to date over 400 rails have been produced in captivity (Derrickson 1996).

The captive management of the Guam rail uses the metapopulation approach, which calls for the establishment of more than one subpopulation (Foose et al. 1986). This has been accomplished by dispersing the captive rails into two primary captive populations on Guam and in U.S. zoos. Because reintroduction of the Guam rail to part of its historical range on Guam is a recovery objective, the establishment of an experimental wild population on snake-free Rota was proposed (USFWS 1989), to serve as a third genetic reservoir to

prevent genetic drift and inbreeding, and to ensure the maintenance of behavioral adaptations for the wild. Reintroductions of captive produced animals are less likely to succeed than translocations of wild-caught animals because of behavioral deficits (Griffith et al. 1989). Experience gained in releasing Guam rails on Rota will provide valuable information, and perhaps birds, useful for future reintroductions.

OBJECTIVE

Establish a non-essential, experimental wild population of the Guam rail in suitable snake-free habitat on Rota, CNMI.

PROJECT HISTORY

In 1987, a Memorandum of Understanding was signed between the Government of Guam, CNMI, and USFWS for the establishment of an experimental population of Guam rails on snake-free Rota. An environmental assessment was prepared for the USFWS covering the introduction of the Guam rail to Rota. The DAWR reached an informal agreement with Dr. Stuart Pimm, University of Tennessee, and by which a graduate student resided on Rota to monitor the initial two rail introductions in cooperation with the DAWR as a part of his dissertation research. Dr. Pimm was successful in receiving several grants from international conservation organizations to support efforts to monitor the introductions on Rota.

After a permit to establish an "non-essential experimental population" of Guam rails on Rota was published (USFWS 1989), 22 rails were released at a site on the Sabana on Rota in December 1989 and January 1990. All but one rail were released with radio transmitters attached in order to monitor their dispersal, mortality and possible breeding success. The site proved to be unsatisfactory probably due to the presence of dense grassland habitat. Of the 22 released birds, the whereabouts of 9 were unknown as their radios failed, 4 were killed by vehicles, 2 were killed by cats, 2 apparently died of starvation, 1 died of poisoning, and 4 died of unknown causes (Witteman et. al. 1990, DAWR 1991).

In February 1991, 31 rails were released at the forest edge in I Chenchon Park near the Bird Sanctuary Overlook (Witteman and Beck 1991). This release appeared to be more successful than previous ones. Releases were discontinued until the spring of 1995 due to the low production of rails at captive breeding facilities.

For the 1995-1996 releases, the release site was moved further inside the forest east of the 1991 site. A total of 75 Guam rails were released during 1995-1996: 15 in March 1995, 30 in August 1995, 15 in September 1995, and 15 in April 1996. Extensive efforts were made to remove predators from the release area prior to the August and September releases after six birds from the March release were preyed on within three days of release. Thirty-five rails were instrumented with radio transmitters. Mortality was high as 19 rails were confirmed dead. Ten of these deaths were caused by predation (primarily by feral cats), one case of septicemia was confirmed, and the cause of death of the remaining eight birds was unknown. Six radio transmitters emitted mortality signals from below the cliffs in the Sagua'gahga seabird colony, and it was assumed that five of those rails were dead. The remaining radio-marked birds either dispersed from the release area, as an exhaustive ground search was not successful in locating these birds, or their transmitters failed. Following the April 1996 release, there was a problem with some of the transmitters exhibiting frequency drift, which may contributed to difficulties associated with locating lost birds. Some long movements made by radio-marked birds, which traveled greater than 1 km from the release area were documented. One bird was found more than 3 km west of the release site. Rails used supplemental feeding stations, which facilitated observation of

non-radio-marked birds from blinds set near the stations. Eight rails (6 non-instrumented) were recaptured in live cat and rat traps, which also facilitated post-release monitoring of rails. In December 1995, reproduction was documented after an adult non-instrumented male came to a food station with a chick. It was estimated that this chick was 3-4 weeks old, based on plumage characteristics. This chick was captured about a month later, again with the adult male, in a live cat trap near the same area. The young bird has not been seen since then, but the adult male was seen in the area as late as August 1996, 11 months after release. One radio-marked rail established and maintained a territory below the bird sanctuary overlook from May through September 1996.

PROCEDURES

Study Site Description

The release area is a coastal limestone cliff area located on the eastern end of the island on a narrow shelf of native limestone forest bound by upper and lower limestone cliffs (Figure 1). South of the shelf and bordering the ocean is a large seabird nesting colony. The remaining area is a mixture of native forest pockets, scrub (secondary growth), and clearings with coconut plantings.

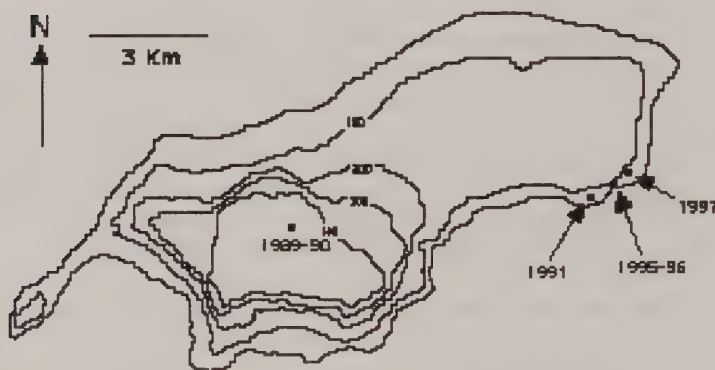


Figure 1. Locations of rail release sites, 1989-1997. Black squares indicate the location of a release site.

Release Method

In an effort to reduce mortality and dispersal, increase site fidelity, and increase the chances of successful nesting and reproduction, a temporary 1.6-ha enclosure was constructed in the eastern end of the former release area (Fig. 1). The enclosure was constructed of 6 ft high 1 inch chicken wire and was tacked to trees in the forest using staples, wire, and plastic ties. Rails were shipped to Rota via commercial airplane. Ten rails (5 males, 5 females) were released on August 4, 1997 inside the enclosure. On September 9, 1997, 2 more females were released inside the enclosure. Two smaller 5 m x 5 m pens were also constructed approximately 400 m west of the large enclosure. These smaller pens were for holding two pairs of rails, one pair of which had successfully bred in captivity. These pairs were placed in their pens on September 9. Two additional males were released on the same date along the trail 300 m west of the large enclosure near a female that had recently escaped. A lone male was also released in the seabird colony near yet another female. All birds had serially numbered aluminum bands on the right leg and were equipped with backpack-mounted radio transmitters.

Predator Control

As many as 24 live traps were set along the trail in the release area to control feral cats (*Felis catus*) and monitor lizards (*Varanus indicus*). The number of traps set varied due to some of the traps being periodically stolen. Stolen traps were later replaced. Cat traps were placed approximately 100 m apart along the trail for a distance of about 2 km. Numerous traps were also placed 50-100 m off the main trail on side trails. Canned cat food was used as bait. Traps were set for capture all day as monitor lizards were also targeted for capture. Following capture of a cat or monitor, the animal was killed with a pellet gun, weighed, measured, classified to age and sex, and its gut contents checked for remains of rails.

Radiotelemetry

All 19 rails were equipped with backpack mounted radio transmitters (AVM Inc.). Radio-marked birds were located using a Telonics TR-2 portable receiver/scanner and a hand-held antenna. Locations of radio-marked rails were recorded. If rails dispersed out of the release area and away from the trail, general topographical and geological features were used to describe the bird's location. Birds were never flushed so as to not disturb any nesting pairs and/or broods and to not drive birds from the release area. Data was collected on survivorship, mortality, and dispersal.

Supplemental Feeding

Supplemental food stations were set up inside the enclosures and in the release area in an attempt to get the rails to stay in the release area. The food (captive diet) was presented in the same manner on Rota as it was in captivity on Guam. Every morning, fresh food was put in a plastic dish under a tent of aluminum and wood to protect it from rain. Once it was determined that a station was being used, a temporary blind was placed near the station to visually monitor the birds. Feeding and mating behaviors were recorded.

RESULTS

Four cats (1 male, 3 female) and 2 monitor lizards were trapped during 1,236 trap nights for the year (3.24 cats per 1,000 trap nights, 1.62 monitors per 1,000 trap nights).

Rail mortality was 32% as six birds were confirmed dead. One of these deaths was due to cat predation, one bird died of apparent starvation, and the causes of death for three are unknown. One death was attributed to an infection when a bird (F340) became entangled in loose thread from its radio harness, nearly severing the medial toe of its left foot. This bird was seen limping severely and was hand captured. Upon further inspection, it had lost 62 gr from its pre-release weight. An attempt was made to save the bird, but it died prior to being sent to Guam later that day. The necropsy showed the bird died of starvation as a result of the infected foot.

Twelve rails (63%) survived to the end of the monitoring period. Five of the birds (42%) escaped from the enclosure during the monitoring period. One bird (M283) either escaped and dispersed from the release area or its transmitter failed. There was a problem with some of the transmitters exhibiting frequency drift. This may contribute to difficulties associated with locating lost birds. Rails that escaped from the enclosure or were released outside moved a mean distance of 756 m away from the release site with the longest documented distance being 2.9 km. Five rails were in the enclosures an average of 10 days (range = 3-18 days) before escaping.

Six rails were observed using the supplemental feeding stations set inside the enclosure, which facilitated observation of birds from blinds set nearby. Of the 6 feed stations, 5 were used regularly by 9 different rails. A male (M300) and female (F679) formed a pair bond and were seen together numerous times at one station. They were never observed with any chicks. This pair exhibited some territoriality as they were seen chasing another rail from the food station on one occasion.

DISCUSSION

The capture rate of cats in 1997 was similar to the rate in 1996 (3.90 cats/1,000 trap-nights), but was less than the 1995 rate (7.86 cats/1,000 trap-nights). This drop in capture rate and the low number of rail deaths attributed to feral cat predation in 1996 and 1997 may be an indication that trapping is reducing the cat population. It may also be possible that cats still in the area are habituating to the traps. To avoid the habituation to trap location by cats, traps were periodically relocated.

The capture rate of monitor lizards in 1997 was down from 1996 (3.90 lizards/1,000 trap-nights). Although the traps are certainly biased toward mid-sized lizards (the traps exclude very small and very large lizards), the decrease in the number of monitors captured may indicate that trapping is effective in keeping their numbers down. Although there is no direct evidence that monitors prey on adult rails, chicks, or eggs, they are a potential predator of all these.

No rat trapping was conducted in 1997 due to time constraints associated with constructing the enclosures and the risk that traversing a rat trapping grid on a daily basis may be a disturbance to the rails. Despite a lack of direct evidence indicating rats have predated rail nests or chicks, rats remain as potential predators on both. Based upon previous trapping, the density of rats in the release area is extremely high.

The 1.6-ha enclosure constructed in the release area was successful in increasing the survival of the birds as 12 rails (63%) lived to the end of the monitoring period, however, five birds (42%) escaped during the monitoring period. Of the five birds that escaped, only two lived to the end of the monitoring period. Further, of the three birds released outside the enclosure, two died within eight days of release. If the birds did escape or were released outside the enclosure, their dispersal averaged 756 m from the release site (range 0-2.9 km). This is comparable to 1996's value of 519 m.

The fence was also successful in reducing cat predation as none of the birds that stayed inside the enclosure were preyed on by cats, whereas at least one rail deaths outside the enclosure was attributed to cat predation. One of the cats trapped during the monitoring period was captured in a trap set next to the fence line. The fence may have acted as a drift fence directing the cat toward the trap.

Previously paired birds were housed in separate release cages (5 m x 5 m). One pair had successfully bred in captivity on Guam, while another pair was young and had not bred previously. The older pair stayed in their pen the entire monitoring period (22+ days), but showed no signs of breeding or nesting during this time. The male of the younger pair escaped within 2 hours of being put in the enclosure so the decision was made to immediately release the female as well. A supplemental feeding station was put in the area in hopes of reducing dispersal, but the female quickly moved far to the east while the male moved slowly to the west. The pair never reunited following their separation. The small enclosures may help to reduce dispersal and mortality, provided the rails don't escape from the enclosure. The enclosures may also need to be made larger in order to accommodate a breeding pair. A larger enclosure may reduce stress and give the birds more room to move,

forage, find adequate nesting sites, and hide from the investigator when food and water is brought in daily.

Survivorship may be partially dependent on supplemental feeding as rails that escaped from the enclosure did not live as long as birds that stayed in the enclosure and used supplemental food stations. One rail (F509) died of apparent starvation inside the enclosure, just 8 days post-release. It is unknown if this bird was physiologically compromised prior to release. Its pre-release weight was only 195 g, the lightest of any of the released birds. Additionally, this bird was part of the second release cohort in September. If the birds in the enclosure from the August release had already set up and were defending territories, this female may have been excluded from foraging at the food stations by the other birds. Supplemental food stations may have played a role in defining (or defending) territories inside the enclosure and may be the reason why 42% of the birds escaped from the enclosure. There also may not have been enough resources for the number of birds inside the enclosure. Of the 5 birds that escaped from the large enclosure, 4 were female.

There was significant frequency drift with the transmitters as 13 (68%) drifted an average of 0.007 Mhz from their original frequencies (range = 0.002-0.010). The lost signal of M283 may be attributed to frequency drift and possible subsequent radio failure. Some of the lost signals may also be attributed to birds dispersing so far from the release site that the chances of finding them were significantly reduced or from birds getting into areas inaccessible with a hand-held antenna.

RECOMMENDATIONS

1. Continue to trap and remove feral cats and monitor lizards from Sagua'gahga forest and surrounding areas.
2. Control rat populations by using kill traps in the immediate release area at least 1 month prior to release, but discontinue trapping once birds are released to reduce disturbance to birds and the chances of capturing birds in the traps.
3. Attach radio transmitters to all released birds in order to obtain more data regarding dispersal, mortality, and reproduction.
4. Investigate ways to improve the enclosure to reduce the escape rate of rails.
5. Investigate the possibility of changing the release site or releasing some birds to an area where dispersal may be limited
6. Continue to release cohorts of 15-20 birds minimum, every 3-6 months until the birds become established. Attempt to release at least one mated pair in each cohort.
7. Begin periodic aerial surveys to find radiomarked birds that may have dispersed from the release area.
8. Continue the use of supplemental feeding stations as this may help to reduce dispersal and facilitates observation of birds.
9. Investigate alternative radio transmitter suppliers.

ACKNOWLEDGMENTS

The DFW staff on Rota was extremely helpful in supplying manpower and vehicles. Conservation officers assisted in carrying the rails and fencing into the forest. DFW biologist Stan Taisacan assisted in various aspects of the program, including transportation and office support. USFWS biologists provided assistance with monitoring released rails.

PROGRAM COST

The estimated cost of the project is \$90,333.

LITERATURE CITED

- Derrickson, S.R. 1996. Guam rail studbook. National Zoological Park, Conservation and Research Center, Front Royal, VA. unpublished.
- Division of Aquatic and Wildlife Resources (DAWR). 1961-1995. Job Progress Reports - Federal Aid to Fish and Wildlife Restoration. Guam Dept. of Agriculture.
- Foose, T.J., R. Lande, N.R. Flesness, G. Rabe, and B. Read. 1986. Propagation plans. Zoo Biology 5:139-146.
- Griffith, B., J.M. Scott, J.W. Carpenter, and C. Reed. 1989. Translocation as a species conservation tool: status and strategy. Science 245: 477-245.
- USFWS. 1989. Federal Register Vol. 54, No. 208.
- Witteman, G.J. and R.E. Beck, Jr. 1991. Decline and conservation of the Guam rail. pp. 173-178 in Maruyama, N, B. Bobek, Y. Ono, W. Regelin, L. Bartos and P. Ratcliffe, eds. 1991. Wildlife Conservation, Present Trends and Perspectives for the 21st Century, Proceedings of the International Symposium on Wildlife Conservation, 5th International Congress of Ecology, Yokohama, Japan. 44 pp.
- Witteman, G.J., R.E. Beck, Jr., S.L. Pimm, and S. R. Derrickson. 1990. The decline and restoration of the Guam rail, *Rallus owstoni*. Endangered Species Update 8:36-39.

Report was prepared by: Grant Beauprez and M. Kelly Brock

JOB PROGRESS REPORT RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: E-1-12

STUDY NO.: 4

JOB NO.: 3

JOB TITLE: Development and Testing of Control Methods for Enhancing Reproduction Affected Endangered Native Forest Birds and Fruit Bats (1470)

PERIOD COVERED: October 1, 1996 to September 30, 1997

SUMMARY

Field tests of electrical barriers designed to prevent predation at Mariana crow, *Corvus kubaryi*, nests by brown tree snakes, *Boiga irregularis*, were conducted at one nest site. Eggs were not laid, but normal nest attendance was observed when a dummy egg was placed in the nest before it was abandoned by the pair. No other nests were found, although one other pair did try to start a nest several times but failed. Eight captive crows, six Rota zoo crows and two hand-reared Guam crows, were released into the wild in northern Guam. Four Rota birds (one male, three females) are known alive, the status of a female hand-reared Guam bird is unknown, and three are confirmed dead. Of the three that died, two were victims of predation, probably monitor lizards or cats, and the third apparently died of natural causes, i.e., infection or sickness. Based on telemetry, released birds ranged from a few hundred to as much as 3 km from the release site. The released crows have adjusted well to their new surroundings and all have interacted with wild Guam crows. Although no breeding activity was observed, one Rota female did pair up with a male Guam crow.

BACKGROUND

Roadside counts by the Guam Division of Aquatic and Wildlife Resources (DAWR) have documented the decline of the native forest birds of Guam (DAWR 1974-1988). Studies by Conry (1988) and Savidge (1987) have indicated that predation by brown tree snake is the main cause of this decline.

Since these studies, attempts to develop effective means of protecting active nests of Mariana crows have been made. Clearing of vegetation in direct contact with the nest tree, snake trapping, use of galvanized sheet metal girdles, and use of the adhesive resin Tanglefoot® have all been used as snake barriers around nest trees. The use of sheet metal girdles and Tanglefoot was partially successful but resulted in the mortality of nest trees and was discontinued. One fledgling was fledged from a nest in 1989 as a result of Tanglefoot protection.

Since 1990, active nests have been protected successfully with the use of a combination of electrical barriers placed on the trunks of active nest trees and clearing of vegetation around the tree (Aguon et al. 1992). Successful protection of active nests resulted in the fledging of three crows from two nests in 1992 (DAWR 1992) and two from two nests in 1994 (DAWR 1994). These were the first fledglings in the wild since 1985 (Michael 1987), with the exception of the one produced as a result of Tangle-Foot protection in 1989.

OBJECTIVES

To develop methods for controlling brown tree snake predation on active nests of native birds and apply these methods to protect active crow nests.

PROCEDURES

1. Develop methods for snake-proofing active native forest bird nest sites.
2. Implement snake-proofing methods at Mariana crow nest sites.
3. As a result of the National Research Council's (1997) recommendation, 2 hand-reared Guam Mariana crows and 6 Rota Mariana crows, transferred from the National and Houston Zoos on February 22-23, 1997, were soft-released into the wild in northern Guam.
4. The crows were instrumented with a 7 or 10 g radio transmitter (see Figure 4 for harness design) after they were weighed, measured for wing, tail, tarsus, bill length, and banded with a numbered band (size 4) and a unique combination of color bands.
5. After an acclimation period of 4-7 days to the radio transmitters, the birds were weighed again (to confirm no significant weight loss) and the harness/transmitter inspected for any fraying or defect.
6. Captive birds were transferred to a snake-proofed hacking box, measuring 1.8 m wide, 1.8 m high, and 3.0 m long (Figure 5). Seven of the eight crows were held in the box for at least seven days prior to being released, which allowed acclimation to the surrounding area. The eighth crow was released two hours after being placed in the hack box. Fresh food was provided daily and the birds were allowed to feed *ad libitum*. Food consisted of moistened dry dog food, mice pinkies, lizards, and live mice. In addition, wild caught grasshoppers, caterpillars, and other potential food items were provided.
7. After the crows were released from the hack box, movements of released crows were monitored daily during the first 90 days of their release and every third day after that via telemetry. For each day, 1-3 locations of each crow were obtained. Multiple locations obtained on a single day were at least one hour apart. Visual observations were made of the released crows daily for at least the first month of their release. For each observation, the date, time, weather conditions (percent cloud cover, wind speed, and presence or absence of rain), habitat type, activity of the bird, species of tree used, location in tree, and height above ground were recorded.
8. After being released (site locations, see Figure 1), supplemental feeding was provided via an elevated food platform at the hack site until the birds became successful foragers on natural food items and ceased consumption of supplemented food.
9. Efforts to trap unbanded wild birds around the hack site were made. Noose traps and mist nets were used to trap crows and were not left unattended (Figure 6).
10. Recovered remains of any released birds that died were necropsied to determine possible cause of death. When possible, specimens will be kept for museum purposes as partial skeletons or skins.

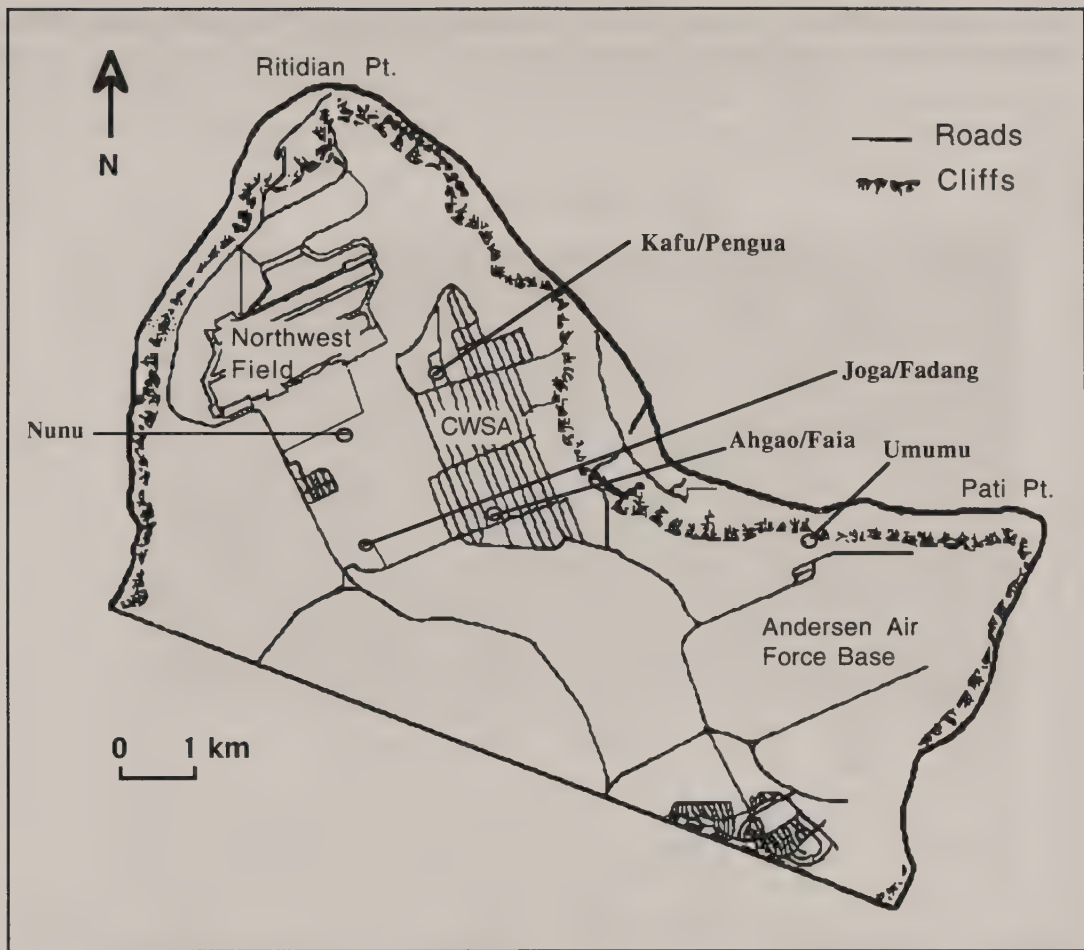


Figure 1. The location of release sites of captive Mariana crows in Northwest Field, Conventional Weapons Storage Area (CWSA), and near the cliffs of Andersen Air Force Base.

RESULTS

Nest Protection

Field use of electrical barriers to protect nests of the Mariana crow from predation by brown tree snakes and monitor lizards, *Varanus indicus*, continued this fiscal year. The design of this barrier is illustrated in Figure 2. This design proved highly effective in control field experiments in 1995 (DAWR 1995). The electrical barriers were powered by 12-volt lead acid batteries and were also equipped with solar panels, which lessened the frequency of battery replacement.

Intensive searches were carried out in northern Guam to locate crow territories and nests during the breeding season (approximately November to May). When an active nest was discovered, an electrical barrier was installed on the trunk of the nest tree at night prior to completion of the nest. Night installation was done to avoid undue disturbance to the nesting birds. Installation before completion of the nest allows for the removal of snakes by trapping prior to egg laying. Trapping for snakes usually involved 4 traps around the nest tree and 1 in the nest tree. Care and feeding of the mice used as bait in the traps and

maintenance of the barrier occurred on a regular basis under the cover of darkness, usually during the early morning hours before sunrise.

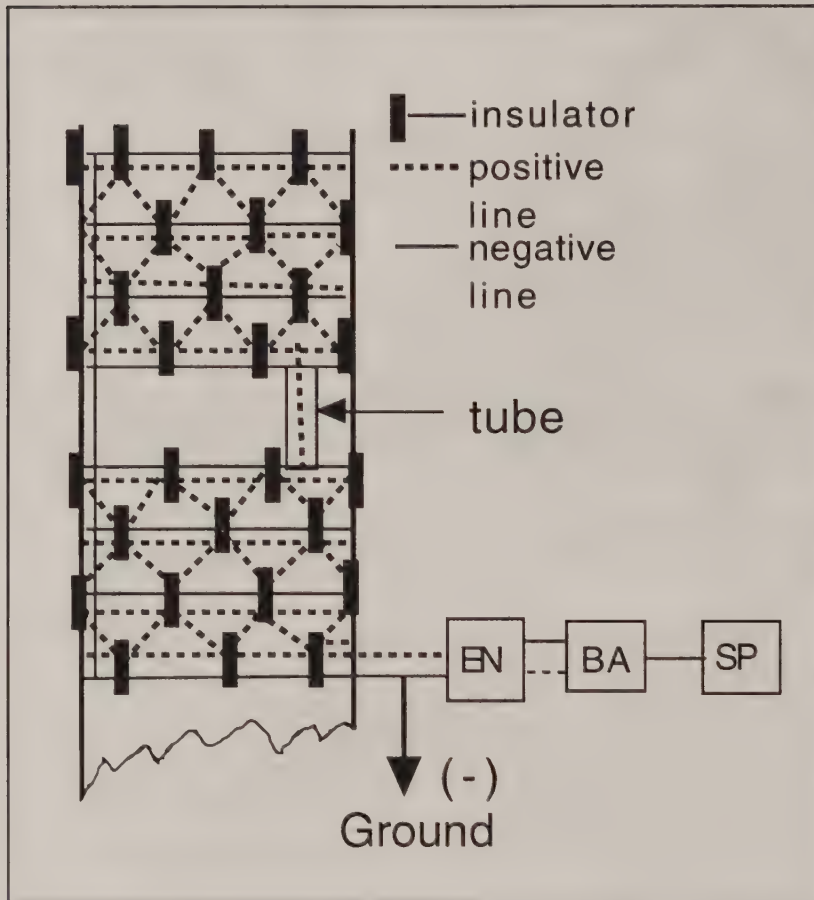


Figure 2. The electrical/hardware cloth barrier is assembled by first wrapping galvanized cable around the trunk of the tree and attaching one end to a steel rod inserted into the ground to form the negative line. Insulators are nailed to the trunk in a staggered pattern and a separate length of cable is placed onto them to form the positive line. The end of the positive and negative lines are then connected to an electrical fence energizer (EN) powered by a 12-volt DC lead acid battery (BA). A 300-watt solar panel (SP) is used to maintain the battery charge and reduces battery changes. The metal shelf is attached flush to the tree between the upper and lower electrical sections. A hollow plastic tube is used as an insulator to prevent grounding between the metal shelf and the positive line.

Breeding activity this year was very poor. On January 21, the only active Mariana crow nest tree was found and snake-proofed six days later when the nest was nearly completed. Installation of this barrier took 9 man-hours (no. of hours x number people). Barrier voltage ranged from 5,100-5,200 volts.

This nest was built by the "Tarague Jeep Road" pair, which had a history of building nests and abandoning them without laying eggs. Egg production was not expected with this latest attempt. The pair abandoned the nest the day after the barrier was installed and was observed starting a new nest about 30 m away. A dummy egg was placed in the first nest on February 3 and on that same day, the second was destroyed. This forced the birds back

to their first nest and on February 9, they were observed incubating the dummy egg. Nest attendance was very high (80-99%) during next 21 days before the birds abandoned the nest (Figure 3). No other nests were known to be constructed by this pair.

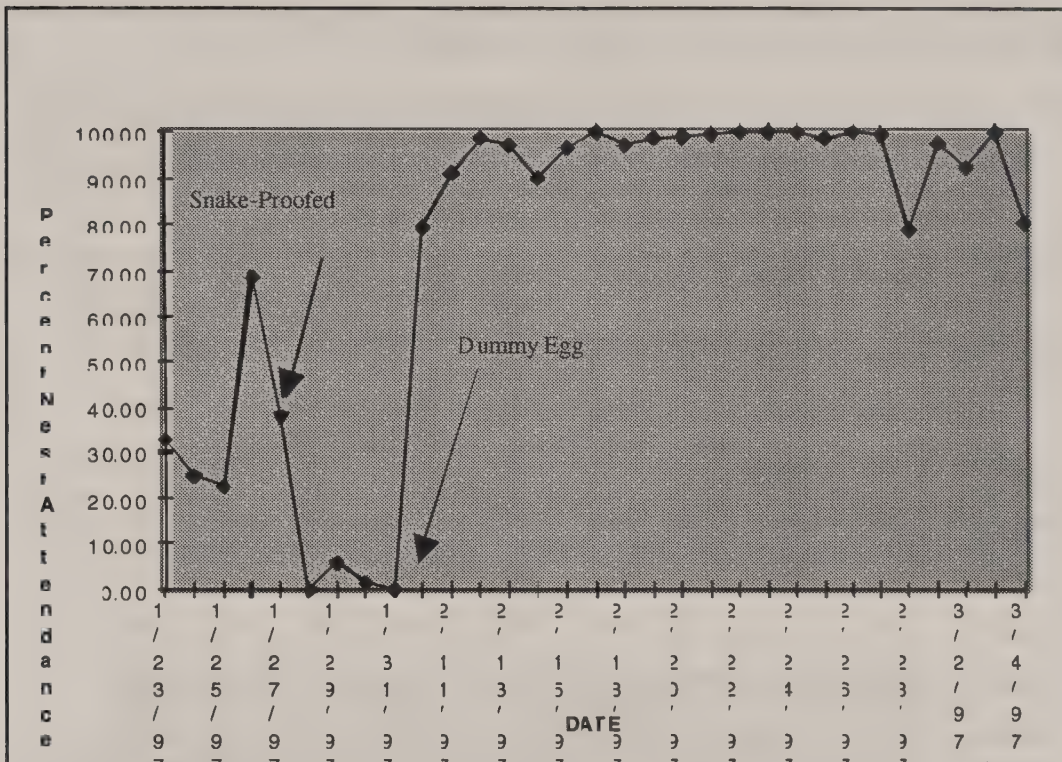


Figure 3. Nest attendance at the only nest found during the 96-97 crow breeding season. The nest was constructed by the "Tarague Jeep Road" pair, who began incubating after a dummy egg was placed in the nest. They abandoned the nest after March 4, 1997, even though the dummy egg was still present in the nest. The nest was snake-proofed.

While snake-proofing is important in improving the nesting success of crows by preventing snake predation, other additional factors are limiting reproductive success. The lack of breeding activity this season is more evidence of an aging population of crows on Guam. It is recommended that other management techniques be implemented (e.g., translocation of fertile eggs or nestlings from Rota) to improve the reproductive success of these birds.

Hacking Mariana Crows into the Wild

A review of the Mariana crow recovery program was recently completed by the NRC (1997). Their recommendations included releasing on Guam all Mariana crows being held in captivity at mainland zoos to help recovery efforts. Of the 12 birds eligible to be released during this breeding season, two were from the DAWR breeding facility (a male and female), 3 pairs and a female were from the National Zoological Park Conservation Research Center, and a pair and female were from the Houston Zoo. Eight Mariana crows were eventually released into the wild on Guam during January, March, April, and June 1997, including 5 from the National Zoo, one from the Houston Zoo, and the 2 hand-reared Guam crows. Two crows remain in captivity at the Houston Zoo, while 2 others died after the report was published.

Prior to their release, the birds were measured and weighed. The weights of the zoo birds were compared to their arrival weights to determine changes. All the crows transferred from the zoos showed excellent adjustment to their new surroundings and gained an average of 25 g (SD = 8.9 g, Table 1). A male crow, named “Kafu”, was showing some signs of stress as his crown and nape were defeathered. Despite this, he appeared to be adjusting to his new outdoor aviary, as did the other crows.

Table 1. Measurements of captive crows from Guam (hand-reared) and Rota (i.e., National Zoo [NZ] and the Houston Zoo [HZ]) prior to their release. Two body mass measurements are given for the zoo birds; arrival weight on Guam (ArWt), and weight before being instrumented (TxWt). Before being fitted with transmitters, birds were measured for bill, tarsus wing chord, and tail lengths. The mean and standard deviation (SD) for these measurements are given.

Band No.	Source	Name	Sex	Bill	Tarsus (mm)	Wing Chord	Tail (mm)	ArWt (g)	TxWt (g)	Wt Diff.
76469-301	Guam	Joga	M	45.0	53	220	140.3		260	
671	Guam	Nunu	F	40.6	49.1	200	125.0		190	
76469-302	HZ	Fadang	F	43.1	51.6	278	148	220	255	35
76469-303	NZ	Kafu	M	55.9	51.2	238	160	250	280	30
76469-304	NZ	Pengua	F	44.9	49.15	230	155	230	255	25
76469-305	NZ	Umumu	F	44.3	50.7	238	155	220	250	30
76469-307	NZ	Faia	F	47.7	51.6	230	146	210	230	20
76469-306	NZ	Ahgao	M	47.6	50.4	234	161	285	295	10
Mean				46.1	50.8	234	149	236		25
SD				4.6	1.3	22	12	28		8.9

After the determining the crows were ready for release, the birds were fitted with radio transmitters weighing 7-10 g and a harness made of teflon tubing (Figure 4).

Instrumentation of the birds took about 45 minutes. Birds were kept fairly calm by placing a cotton sock hood over their heads. They were transferred to release sites in Northwest Field, CWSA, and Pati areas (Figure 1) and placed in a hack box (Figure 5).

The crows spent an average of 18.8 days (SD = 14.2 days, range = 1-41 days; Table 2) before being released. However, one female, named “Umumu”, was released two hours after she was placed in the hack box. Time in the hack box also gave additional time for the birds to adjust to the transmitter. The harness did not appear to cause abrasions or discomfort to the birds.

After a short adjustment period of two weeks or less, the birds were transferred to the hackbox. Prior to their release, the crows spent an average of 10 days (SD = 8.8 days, range = 0-29 days; Table 2). A male hand-reared Guam crow, named “Joga”, spent the longest time in the hackbox (29 days), as he was allowed more time to adjust to the environment and feed on wild-caught insects and skinks. Of all the released birds, Joga

exhibited the greatest affinity for humans. Umumu spent only a few hours in the hackbox and was quickly released to encourage a wild male in the territory to pair with her.

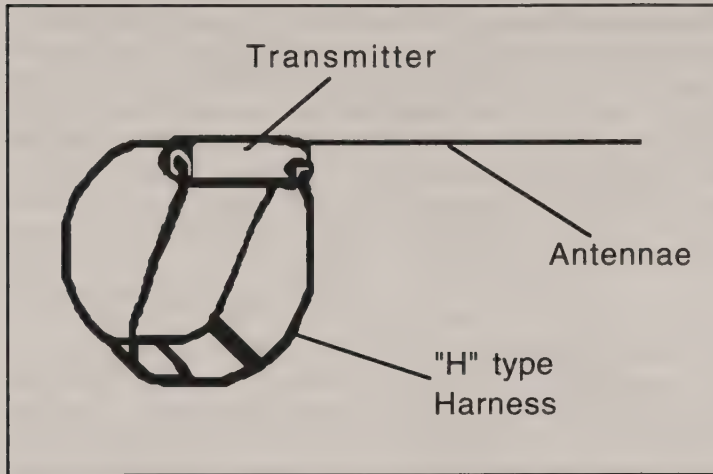


Figure 4. Hacked crows will be instrumented with transmitters using "H" type harnesses made of 1/4 inch Teflon ribbon (J. Marzluff, pers. com). The transmitters are rated for 500 days and are configured to be on 16 hours and off 8 hours during the first 90 days, after which they will switch to a 16-hr on and 56-hr off cycle.

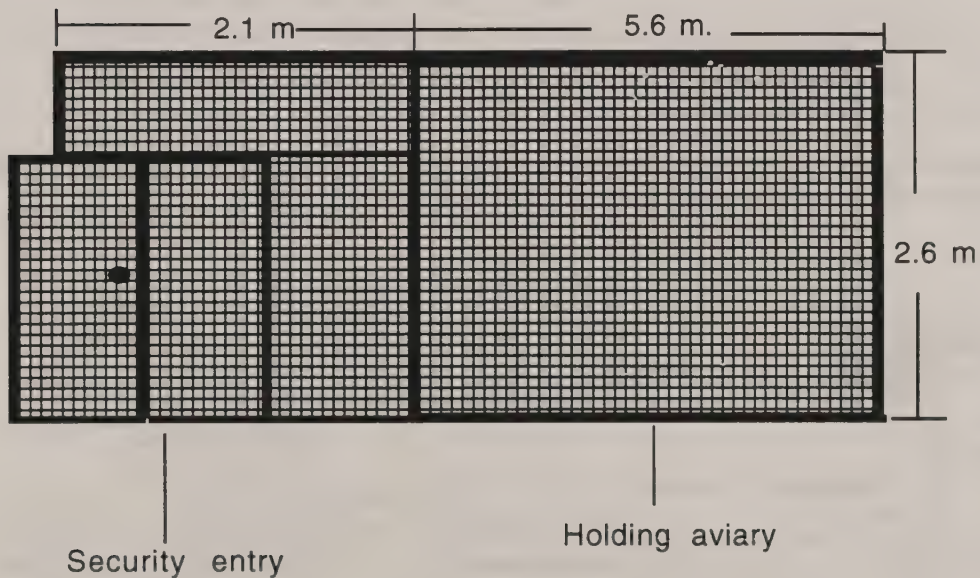


Figure 5. Overview of the outdoor aviary used to hold crows transferred from mainland zoos. The security entry prevented accidental escapes.

Table 2. The number of days each crow had its radio transmitter on before being released (Tx) and the date of its release. The number of days survived is given only up through September 30, 1997.

	Name	Sex	Date Released	Tx	Days Hackbox	Survived
1	Joga	M	1/15/97	36	29	219
2	Nunu	F	2/15/97	27	16	63 ¹
3	Fadang	F	3/19/97	8	5	195 ²
4	Kafu	M	4/1/97	12	7	34
5	Pengua	F	4/1/97	12	7	182 ²
6	Umumu	F	4/2/97	1	0	13
7	Faia	F	6/11/97	13	8	111 ²
8	Ahgao	M	6/11/97	41	8	111 ²
Mean				18.8	10.0	116.0
SD				14.2	8.8	76.9

¹Nunu's radio failed after 63 days and her status is unknown.

²These birds were alive through September 30, 1997.

Efforts to trap unbanded wild birds around the hack site were made. Noose traps and mist nets were used to trap crows and were not left unattended (Figure 6).

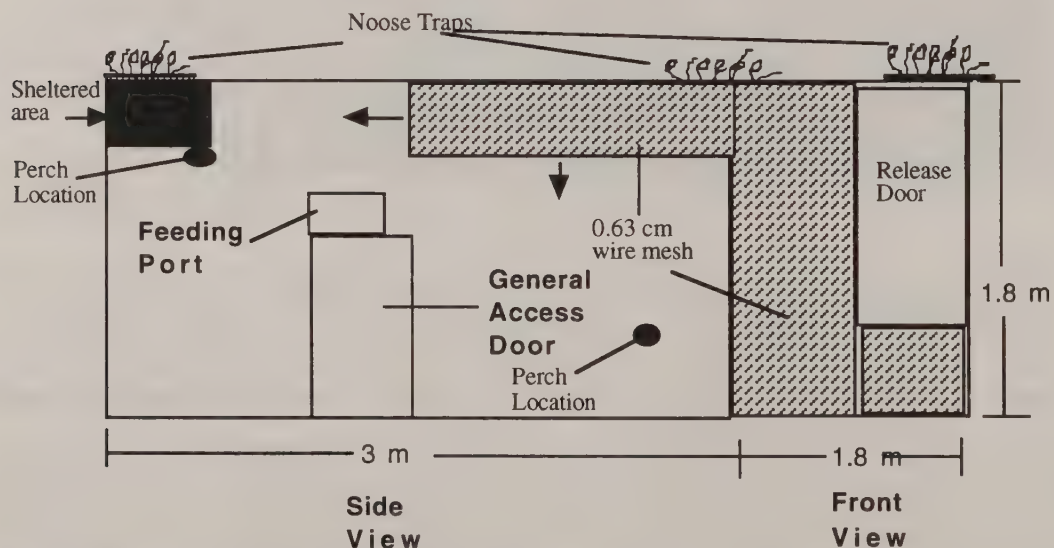


Figure 6. Hacking box with noose traps attached to the exterior upper corners of the box to catch unbanded wild crows.

Survival of Released Crows

Survival of released crows averaged 116 days ($SD = 76.9$, range = 13-219; Table 2). Joga, a male crow named "Kafu," and Umumu survived 219, 34, and 13 days in the wild, respectively. Joga and Kafu were possibly preyed on by monitor lizards or cats, since the deaths were believed to have occurred during the daytime. Kafu was blind on the right eye, probably making him vulnerable to predation. Umumu's carcass was found intact beneath a rock in the Tagua Point area. On May 17, a captive-born zoo female crow, named "Fadang", was found being held on the ground by a monitor lizard. The deaths of two crows and almost a third by monitor lizards or cats indicates that ground predators should be controlled for in future releases.

Movements of Released Birds

Captive crows were fitted with transmitters manufactured by Advanced Telemetry Systems weighing 7-10 g. Locations of birds were determined by triangulations based on three bearings. Accuracy of these bearings were determined by using a "dummy" transmitter placed on the ground or above the ground (in a tree) at distances less than 100 m, greater than 100 m, and greater than 200 m from the person triangulating. The differences in distances between true and triangulated locations ranged from 50-105 m (Table 3). Ground measurements were most accurate when between 100-200 m from the observer. Above ground measurements were most accurate at distances less than 100 m (mean = 49.6 m, $SD = 31.9$ m; Table 3).

Table 3. The difference between the actual location of a "dummy" transmitter and the location based on bearings. Two different heights (ground and tree height) and three distance categories were used to determine accuracy based on telemetry. A U.S. Geological Survey map of the Conventional Weapons Storage Area (scale: 1:24,000) was used in the test.

Distance (m)	Height =	Ground	Tree
<100	MEAN	58.3	49.6
>100	STD	23.2	31.9
>200	N	10.0	10.0
<100	MEAN	27.7	105.4
>100	STD	12.6	70.1
>200	N	10.0	10.0
<100	MEAN	79.0	67.2
>100	STD	33.6	43.7
>200	N	10.0	10.0

On January 15, Joga was released in the CWSA (Figure 1), an area occupied by an unmated female, named "C1". Though the birds were seen together many times, they did not pair. Joga's average distance from the release site during his first week after release averaged 574 m ($SD = 558.0$ m; Table 4). During the following weeks, he made many visits to the supplemental feeding platform, which was stocked with food, but he was eventually weaned from it.

Following Joga's release, Fadang was released in the same area on March 19 after it appeared the C1 female was not pairing up with Joga. After Fadang was transferred to the hackbox, Joga was recaptured and placed in the hackbox with her. This pair had exhibited pair bonding behavior as they were observed allopreening and perching side by side. After their release, they were observed constantly foraging, perching, and flying together. The

C1 female was seen on many occasions following the pair. Average weekly distance traveled by Joga and Fadang ranged from 0-792 m from hacksite (Table 4). Soon after Joga's death on August 22, Fadang's radio had failed.

Table 4. Average weekly distance traveled by Joga and Fadang from the hacksite after their release. Joga was released on January 15 and Fadang on March 19.

Week	Mean	STD	N	Notes
1	574.13	558.04	8	Joga alone
2	93.62	103.08	7	Joga alone
3	345.99	299.13	8	Joga alone
4	96.61	171.28	8	Joga alone
5	62.94	76.03	8	Joga alone
6	36.06	0.00	8	Joga/Fadang
7	36.06	0.00	8	Joga/Fadang
8	21.63	19.75	5	Joga/Fadang
9	0.00	0.00	6	Joga/Fadang
10	178.60	125.84	5	Joga/Fadang
11	269.15	328.54	11	Joga/Fadang
12	731.27	199.55	9	Joga/Fadang
13	317.57	199.51	22	Joga/Fadang
14	287.30	186.47	29	Joga/Fadang
15	252.76	102.24	27	Joga/Fadang
16	250.60	151.23	22	Joga/Fadang
17	112.18	55.60	32	Joga/Fadang
18	190.23	113.06	30	Joga/Fadang
19	172.93	145.30	29	Joga/Fadang
20	230.67	197.88	32	Joga/Fadang
21	257.03	184.45	31	Joga/Fadang
22	135.18	145.21	30	Joga/Fadang
23	792.16	156.05	31	Joga/Fadang
24	772.60	373.40	31	Joga/Fadang
25	525.30	365.24	11	Fadang's radio failed
26	418.43	412.52	9	
27	132.26	44.91	2	Joga dead - 8/22/97

A hand-reared female Guam crow named "Nunu" was released in Northwest Field on February 15 (Figure 1). Very little site fidelity was observed as Nunu's average weekly distance traveled ranged from 751-2,500 m (Table 5). Aside from feeding on food placed on the supplemental feeding platform during the first couple of days, Nunu spent most of her time away from the hacksite. She was observed spending several days at a time in the old housing area in Northwest Field, located about 500-600 m from the hacksite. The area is composed of a mixture of open fields and forest. Insect densities were abundant in this area. No observations of Nunu were made after her radio failed on April 23.

Table 5. Average weekly distance traveled by Nunu from the hacksite. This hand-reared female Guam crow was released on April 23.

Week	Mean	STD
1	750.56	795.71
2	575.06	646.69
3	1280.83	157.04
4	1123.46	111.23
5	2342.76	383.19
6	2996.98	210.10
7	1555.61	632.84
8	2073.38	327.00
9	2506.15	103.78

Kafu and a female zoo crow named “Pengua” were released as a pair in the CWSA area on April 1 (Figure 1). Their average weekly distance traveled during the first 5 weeks ranged from 314-945 m from the hacksite (Table 6). This pair did not use the supplemental feeding platform and was seen foraging in native trees (e.g., *Pandanus* and *Elaeocarpus*) immediately after their release. They seemed to be well suited for each other, and were observed foraging together and staying in close proximity of each other. However, on April 19, Pengua was not with Kafu and was later seen with two other unbanded crows on the north side of CWSA. She was reunited with Kafu on April 21 and the two remained together until Kafu’s death on May 5.

Table 6. Average weekly distance traveled by Kafu and Pengua from their hacksite after their release. Released on April 1, they remained together for most of the time until Kafu’s death. Pengua has since interacted with other crows, but has not paired up with any of them.

WEEK	MEAN	STD	N
1	313.95	262.33	19
2	858.35	331.99	19
3	809.46	502.15	13
4	231.98	204.90	18
5	944.49	640.88	5

A female zoo crow named “Faia” and a male zoo crow named “Ahgao” were released together in the CWSA area on June 11 (Figure 1). After their release, the pair separated; Faia had followed a male crow named the “11B6 male”, whose territory was nearby. This male had visited the hacksite many times while the birds were still in the hackbox. Though both males were seen aggressively vocalizing to each other, activity settled down in the following days. Ahgao spent several weeks in this male’s territory before venturing into adjacent areas in CWSA.

Because Faia and Ahgao separated after their release, data on average weekly distance traveled for each bird is reported separately. Ahgao's average weekly distance traveled during the first 13 weeks of his release ranged from 584-2,420 m from the hacksite (Table 7). Besides his interaction with the 11B6 male in CWSA, he also encountered Joga and Fadang in the "Handicap" hunting area, 2,700 m from his hacksite. There were aggressive vocalizations (high pitched calling) between Joga and Ahgao, but no physical contact was observed. In subsequent days, Ahgao returned to the CWSA area near the 11B6 male.

Table 7. Average weekly distance traveled by Ahgao after his release on June 11. He was released with Faia, but the two had separated immediately after.

WEEK	MEAN	STD	N
1	583.85	333.73	34
2	508.18	70.50	31
3	428.46	111.93	32
4	464.99	236.82	29
5	761.33	206.75	28
6	935.36	248.45	27
7	1816.05	737.36	18
8	2373.61	153.56	22
9	1723.36	603.80	26
10	1898.34	150.08	17
11	2419.71	225.06	9
12	2275.77	40.28	5
13	1874.69	748.82	11

Faia's average weekly distance traveled during the first 13 weeks of her release ranged from 534 - 779 m from the hacksite (Table 8). After separating from Ahgao upon release, she spent most of her time with the 11B6 male in CWSA. The birds were constantly seen together and it appeared that they had paired up.

Table 8. Average weekly distance traveled by Faia from the hacksite since her release on June 11. She was released with Ahgao, but the two separated since their release. Faia paired up with a male located in the 11B6 CWSA area, but did not breed.

WEEK	MEAN	STD	N
1	603.36	432.56	31
2	622.60	228.17	27
3	601.09	248.69	32
4	562.16	227.66	31
5	741.34	323.00	28
6	779.19	152.65	28
7	724.08	289.37	24
8	583.35	120.43	25
9	669.59	182.60	27
10	534.83	154.23	19
11	633.85	150.54	9
12	699.07	236.20	11
13	578.05	210.68	13
14	534.21	28.99	4

In summary, observations of the eight released captive crows indicated that they adapted well to their new environment. Two of the three crows that died were probably killed by monitor lizards or cats, while the third most likely died from natural causes, e.g. sickness. None died from snake predation. The status of a fourth crow is unknown. The remaining four released crows settled in their new surroundings, all far from their release sites, and are interacting with other Guam crows. One female had paired up with a Guam crow.

RECOMMENDATIONS

1. Operational implementation of proven methods to protect nesting Mariana crows.
2. Conduct *in situ* tests of methods which prove effective in laboratory experiments on actual active nest trees.
3. Explore the feasibility of area-wide snake control and exclusion of snake from larger areas encompassing nesting territories of crows with the use of barriers.
4. Explore and implement other methods or techniques to improve reproductive success of nesting birds to be used in conjunction with nest protection, i.e., translocation of crows from Rota.
5. Implement recommendations by the NRC for the recovery of the Mariana crow on Guam and Rota.

PROGRAM COSTS

The estimated cost for this project under E-1-12 is \$200,000.

LITERATURE CITED

- Aguon, C. F., R. E. Beck, Jr., and M. W. Ritter. 1992. A method for protecting nests of the Mariana Crow from Brown tree snake predation. Proceedings of the US-Japan Joint Congress on Snake Control for Human Health and Wildlife Conservation. The Snake 24:106.
- Conry, P. J. 1988. High nest predation by the brown tree snake on Guam. Condor 90:478-482.
- Division of Aquatic and Wildlife Resources (DAWR). 1974-1989. Job Progress Reports - Federal Aid to Fish and Wildlife Restoration. Guam Dept. of Agriculture.
- Michael, G. 1987. Notes on the breeding biology and ecology of the Mariana or Guam Crow. Avicult. Mag. 93:73-82.
- National Research Council (NRC). 1997. The scientific bases for preservation of the Mariana crow. National Academy Press, Wash., D.C. 91 pp.
- Savidge, J. A. 1986. The role of disease and predation in the decline of Guam's avifauna. Ph.d. Thesis. University of Illinois, Urbana-Champaign.
- Savidge, J. A. 1987. Extinction of an island avifauna by an introduced snake. Ecology 68(3):660-668.

Report was prepared by: Celestino F. Aguon

